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Ten Per Cent. Push—and Go!

Congratulations are due to the West Midland Foundry Advisory Committee on being the first to establish a foundry craftsmanship training centre in the country, thus implementing the excellent scheme evolved by the Council of Ironfoundry Associations. The centre is to be housed in the foundry of Rudge, Littley, Limited, Swan Village, West Bromwich. An instructor of outstanding ability has been appointed, and, though his work will be devoted in the main to the teaching of practical work, he will augment the training by a series of short lectures. Through the generosity of equipment manufacturers' houses, melting and sand-preparing plant, and a core stove have been loaned. The patterns and moulding boxes are being furnished by Rudge, Littley. The floor is being concreted at the expense of the Committee, and on this will be made both ferrous and non-ferrous castings of a commercial character. These will be purchased from the Centre, and thereby the lads will realise the serious value of their work. To this Centre, boys receiving proper training in the local foundries, will come for three periods at extended intervals during the course of their training. This is a new and cardinal feature of the foundry craftsman training scheme and gives the industry a selling point in recruitment unique in the annals of industrial education.

That the scheme has come to fruition so quickly is due, very largely, to the generosity and wholehearted co-operation by the directors of Rudge, Littley. The activities of Mr. Howard Wood, as chairman of the committee responsible, enthusiastically supported by Mr. J. W. Gardom, have constituted the main driving force, and Midland foundry owners share in our gratitude to the committee.

The most serious problem for any scheme of the type of the Swan Village Training Centre is continuity of the supply of suitable lads. In this case there should be no difficulty, as the number of boys now training in the area is no fewer than 933, of whom 254 are attending part-time day training courses. Nor should there be any difficulties in the other large centres of foundry activities. Indeed, for the balance of the country, all that are needed are the formation of a group capable of supplying annually a predetermined number of boys, a suitable centre and first-class instructor. The operation of the West Midland Foundry Advisory Committee's activities will be followed with interest by other centres, but this is no time for hesitancy. Fundamentally, the scheme is excellent, and we counsel the other districts to emulate the Swan Village enterprise. Sufficient progress has already been made to warrant examination by other centres. Early co-operation might indeed be fruitful.

We have long been interested in training schemes, and on this revival of interest in recent times we received from various centres details of enlightened schemes evolved about 1920. They could have been implemented, but the sponsors just lacked that extra 10 per cent. of push to ensure their successful launching. We hope our successor will not be writing in similar terms in 1970, for to-day, that extra 10 per cent. of push exhibited throughout the foundry centres would ensure immediate and permanent success.

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Latest Foundry Statistics

For the first time since the conclusion of hostilities, a decline is shown in employment in ironfoundries. The average total of all employees engaged in ironfoundries for the week ending May 8, 1948, was 145,749 or 189 fewer than on April 10. Of males, however, there were 234 fewer. The quantity of metal melted for the making of steel castings showed a substantial increase in June. At 8,600 tons, it compares with 7,900 tons in May of this year and 7,500 tons in June, 1947. These figures are extracted from July issue of the Monthly Statistical Bulletin of the British Iron and Steel Federation.

British Standards Institution

Sizes of X-Ray Film and Intensifying Screens

B.S. 1443, which has just been published, is of major importance to the medical profession and to all branches of engineering, as it specifies the size of X-ray film and intensifying screens, together with internal sizes of cassettes adopted for future use. The Standard was prepared at the request of the manufacturers of X-ray equipment and accessories, who found it imperative to achieve rationalisation of the many sizes which had come into use in this country for medical and industrial use, since those manufacturers were also faced with the necessity of producing equipment adapted for metric sizes for the export trade.

The committee charged with this work has found it possible, by close consultation with the medical interests and the engineering interests concerned, to provide satisfactorily for all uses with a range of ten inch sizes and six metric sizes, the metric sizes serving also to meet the needs of foreign markets. These sixteen sizes will replace more than thirty formerly in use in this country. The consequent saving to manufacturers of equipment, accessories and material, will ultimately be passed to the users, who will also experience the other benefits of standardisation. The Standard specifies minimum and maximum cutting sizes for X-ray film and intensifying screens, and also provides for a standard minimum size of cassettes; care has been taken to ensure that films and screens of these sizes will be capable of satisfactory use in all existing equipment.

OUR SCOTTISH REPRESENTATIVE recently met Mr. Paul Egenfeldt, of the Smethske Foundry, Aalborg, Denmark, who has been visiting this country in connection with the development of peat-preparing machinery, a line in which his factory specialises.

THE 35-MINUTE TALKIE documentary film "Meet the Pioneers," produced at the Horbury Mining Engineering Works of R. Sutcliffe, Limited, was shown privately at the Savoy Cinema at Wakefield to an audience of 1,000, comprising operatives from the factory and their families. It was rushed through so as to be completed for the Toronto State Fair.

Institute's Golf Meeting

A golf Competition, open to all grades of membership of the Institute of British Foundrymen, will be held on Friday, October 15, 1948, at the York Golf Club, Strensall, York. The morning event will consist of a Medal Round of 18 holes for the I.B.F. Scratch Challenge Cup, and the I.B.F. Handicap Challenge Cup. The winners will also receive a tankard each, kindly presented by Mr. P. H. Wilson, O.B.E., (past-president), and Mr. R. B. Templeton (president). Mr. E. A. Phillips, of Harper, Phillips & Co. Ltd., Grimsby, and Major J. Scott, of Armstrong Whitworth & Co., Gateshead, are the present holders of the Scratch and Handicap Cups. The afternoon event will consist of Greensome Foursomes against Bogey. Entry forms will be circulated with the September issue of the Institute's Journal. Full details of the Competition are given below:

Standard Scratch Score 74

Morning.—Medal Round of 18 holes for the I.B.F. Scratch Challenge Cup and the I.B.F. Handicap Challenge Cup. There will be an optional 5/- sweepstake on the handicap event, to be divided two-thirds to the winners and one-third to the runners-up.

Afternoon.—Greensome Foursomes against Bogey under three-eights of combined handicaps for a 5/- per head sweepstake, to be divided two-thirds to the winners and one-third to the runners-up. Partnerships to be mutually arranged. Ties, if any will be decided on the last nine holes, or if necessary, on the last twelve or fifteen holes.

Handicaps.—Lowest Club handicap at any club—Certificate from own golf club Secretary to be available if required. Handicap *must* be stated when entering so that adjustment where necessary may be made, to be in line with the standard scratch score at Strensall Golf Club.

Caddies.—It is unlikely that any caddies will be available.

How to get to the Course.—By regular bus service every twenty minutes from the Royal Station Hotel, York, to Strensall village (six miles) which is five minutes walk from the Course.

Entries.—To be made as soon as possible after issue of the entry form. Entries will close October 1, 1948.

Entry Fees.—Inclusive fee for the day £1 per head, covering green fee, lunch, tea and foursome competition, or 25/- to include morning singles sweepstake.

Special Note.—Will those staying overnight in York please start their morning round as early as possible so as to help those coming from a distance.

J. SAGAR & COMPANY, LIMITED, HALIFAX, have developed an entirely new automatic grinding machine for slotted and thin planing cutters, embodying many new features and working on an entirely different principle from the conventional type of machine as known hitherto. The machine is made as standard suitable for planing cutters up to 42 in. long. In addition, the machine is made in various sizes over the standard for grinding guillotine knives, wood peeling knives, etc.

New Methods of Ladle De-sulphurising Pig Iron*

Fundamental Researches which emphasise the importance of agitation

By W. C. Newell, Ph.D., D.I.C., F.R.I.C., A.R.C.S. A. J. Langner, B.Sc., and J. W. Parsons, B.Sc.†

Summary

This Paper is an interim report prepared by the Steel Castings Division of the British Iron & Steel Research Association for its Melting Sub-Committee upon its recent theoretical and practical enquiry for new and improved methods of de-sulphurising re-melted iron for iron and steel foundries. The factors examined include slag basicity, various chemically reducing conditions, agitation by gas bubbling and the addition of specific sulphur retaining elements such as barium. It is shown that the degree of mixing with a fluid basic slag is the predominant controlling factor and that the effect of the operation of bubbling with nitrogen is to intermix slag and metal rather than to remove the sulphur proportionately to the gas passed. The merit of sodium carbonate in providing the necessary fluid basic slag is confirmed, but it is also shown that, provided fluidity be maintained, a highly basic calcium silicate slag can act as a substitute for soda ash. The attainment of higher de-sulphurising efficiencies, theoretically possible from new de-sulphurising agents, is shown to be dependent upon the practical control of slag fluidity, intermixing and the state of reduction.

Introduction

The increasing demand for steel of lower sulphur content and the shortage of suitable low-sulphur pig-iron and steel scrap have raised the importance of de-sulphurisation processes. Sodium carbonate has proved itself to be effective, but not without disadvantages, as a ladle addition for this purpose, and recent shortages in its supply have been an added stimulant to the conduct of this enquiry. The fume given off from sodium carbonate is objectionable, and whilst de-sulphurisation of up to 75 per cent. has been obtained, the normal extent under works practice is only around 50 per cent. The object of this investigation was therefore to devise a process whereby the sulphur content of molten iron in a ladle could be reduced to the desired limit in an easy manner and without objectionable fumes.

The Institute of British Foundrymen have already published a preliminary Report on this subject,[1] and to that Report the reader is referred for an introduction to this subject. In the present Report the Authors have sought to review the basic principles of the process and have tried any new material or procedure which might lead to an improved process. Dr. Heuer, of the General Refractories Company of America, in a private communication,[2] suggested that a highly basic slag made fluid by spar addition and bubbled with nitrogen should be extremely efficient as a de-sulphurising process, and the Authors have therefore incorporated in their programme an examination of Dr. Heuer's suggestions. The result is that, whilst the Authors agree that the suggested conditions are favourable, they are not satisfied that the conditions are quantitatively as favourable as was indicated by Dr. Heuer.

Theoretical Review

The de-sulphurising action of lime takes place according to the following equation:—

$$FeS + CaO \rightleftharpoons FeO + CaS \quad \ldots\ (1)$$

the reaction constant of which is

$$K = \frac{[FeO] \times (CaS)}{(CaO) \times [FeS]}*$$

Now since (CaS) is to the first approximation equal to the sulphur in the slag, S_S, and [FeS] to the sulphur in the metal, S_M, it follows that

$$K = \frac{[FeO]}{(CaO)} \times \frac{S_S}{S_M}$$

or

$$\frac{S_S}{S_M} = K \times \frac{(CaO)}{[FeO]}$$

and since similar equations can be deduced for the other possible de-sulphurising reactions, as, for example, with manganese or sodium carbonate, it follows that the sulphur distribution between slag and metal $\frac{S_S}{S_M}$ is linearly dependent upon the concentrations of [FeO], (CaO), (MnO), (Na_2O), etc. Since, therefore, the concentrations of these materials are determined by such factors as the necessary slag fluidity, the cost and the permissible amount of manganese, etc., it follows that for a given reaction the possible variation in the sulphur distribution is strictly limited. Dr. Heuer[2] has advocated a method of lime de-sulphurisation in which a highly basic slag is employed together with a low [FeO] obtained by the passage of an inert gas, such as nitrogen, through the molten iron. The basis for this procedure is that for a given carbon content the [FeO] is lowered proportionately to the partial pressure of CO in accordance with:—

$$C + FeO \rightleftharpoons Fe + CO \ldots\ldots\ (2)$$

*Presented at the London Conference of the Institute of British Foundrymen, June, 1948.

† British Iron and Steel Research Association.

* According to convention, symbols in square brackets refer to concentrations in the metal and those in round brackets to concentrations in the slag.

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Heuer has added equation (2) to equation (1) to produce the following equation:—

$$FeS + CaO + C \rightleftharpoons CaS + Fe + CO \quad \ldots\ (3)$$

from which it is erroneously implied that the quantitative extent of de-sulphurisation is necessarily proportional to the quantity of CO removed from the melt. Actually since equation (2) shows the dominant reaction for carbon monoxide elimination, all that equation (3) shows is that at its equilibrium the *concentrations* of the reactants (including CO) are related in accordance with the requirements of the equilibrium constant $K = \frac{(CaS)\ [Fe]\ Pco}{[FeS]\ (CaO)\ [C]}$

Since there are sources of FeO other than from reaction (1) the quantity of CO removed in accordance with reaction (2) is not necessarily proportional to the sulphur removal to the slag, thus whilst the Authors agree that the de-sulphurising conditions stipulated by Heuer are favourable, they do not agree that de-sulphurisation should increase exponentially with rise in basicity or that the extent of de-sulphurisation is necessarily proportional to the CO removed.

If it be assumed that the slag materials initially are free from sulphur, which for practical purposes they are, then the final sulphur in the slag is that which has come from the metal so that the sulphur distribution factor $\frac{S_S}{S_M}$ is proportional to the loss of sulphur from the metal divided by the final sulphur content of the metal. Thus for small extents of de-sulphurisation, say, less than 25 per cent., the percentage of sulphur loss is closely proportional to the sulphur distribution factor between slag and metal, but for higher degrees of de-sulphurisation the divergence increases rapidly. Theoretically the sulphur distribution factor is more significant than the percentage of sulphur loss, and it has therefore been calculated in the tables of results from the loss of sulphur divided by the final sulphur content of the metal and multiplied by the metal to slag weight ratio.

Assessment of De-sulphurising Force

The de-sulphurising force or a measure of the de-sulphurising tendency is best expressed as the change in thermodynamic free energy ($\triangle F$) which occurs as de-sulphurising proceeds. This is simply related to the reaction constant as follows:—

$$-\Delta F = RT \log_e K$$

which for equation (1) is:—

$$-\Delta F = RT \log_e \frac{[FeO] \times (CaS)}{CaO) \times [FeS]}$$

$$= RT \log_e \frac{[FeO]}{(CaO)} + RT \log_e \frac{(CaS)}{[FeS]}$$

which for a constant state of basicity and oxidation,

$$-\Delta F = K_1 + RT \log_e \frac{S_S}{S}$$

hence $\frac{S_S}{S_M}$ varies exponentially with regard to $-\triangle F$, which means that for different de-sulphurising reactions, maybe with only small differences in their free energy changes, there would be relatively large differences in the theoretical equilibrium sulphur distribution ratios as between slag and metal. Hence it was decided to investigate de-sulphurisation with materials other than lime and sodium carbonate.

The mechanism of the process of de-sulphurisation is essentially the mutual exchange of sulphur for oxygen between two metals, so that the important specific elemental property which must be considered is the free energy change from oxide to sulphide. Thus, for example, for the element calcium, the change is:—

$$CaO + \tfrac{1}{2} S_2 \rightleftharpoons CaS + \tfrac{1}{2} O_2, + \Delta F_{Ca}$$

TABLE II.—*Group A. Experiments involving Bubbling with Nitrogen or Ammonia. Sodium Carbonate/Calcium Silicate/Fluorspar Slage.*

Expt. No.	Scale.	Slag materials. Sodium Carbonate. Per cent.	Tri-Calcium silicate. Per cent.	Fluorspar. Per cent.	Gas.	Initial sulphur. Per cent.	Final sulphur. Per cent.	Percentage S. removed.	$\frac{S_S}{S_M}$
A.1	Lab.	100	—	—	N_2	0.165	0.044	73.4	91
A.2	Works	76	15	9	N_2	0.090	0.044	51.2	70
A.3	Works	42.8	40	17.2	N_2	0.128	0.053	59.0	95
A.4	Works	42.8	40	17.2	N_2	0.119	0.037	69.0	150
A.5	Lab.	31.0	63	6	N_2	0.142	0.047	67.0	67
A.6	Works	27	56	17	N_2	0.106	0.050	53.2	75
A.7	Works	27	56	17	N_2	0.081	0.056	30.9	30
A.8	Works	27	56	17	N_2	0.095	0.063	33.9	34
A.9	Lab.	11	80	9	N_2	0.156	0.093	40.8	23
A.10	Lab.	5.5	89	5.5	N_2	0.151	0.101	33.2	17
A.11	Lab.	—	60.5	39.5	N_2	0.164	0.102	37.8	20
A.1	Lab.	—	60.5	39.5	N_2	0.107	0.085	21.0	9
A.13	Works	—	73	27	N_2	0.124	0.082	33.9	34
A.14*	Lab.	—	100	—	NH_3	0.184	0.129	29.9	43
A.15	Lab.	—	100 Limestone	—	NH_3	0.183	0.164	10.4	12
A.16†	Works	27	56	17	—	0.112	0.046	68.0	96
A.17†	Works	—	61.5	38.5	—	0.116	0.076	34.5	35

* 1 per cent. slag only. † Blank expt. no gas bubbling.

similarly for iron $FeO + \frac{1}{2}S_2 \rightleftharpoons FeS + \frac{1}{2}O_2, + \Delta F_{Fe}$

so that by difference we have our earlier equation (1) :—

$$CaO + FeS \rightleftharpoons CaS + FeO, + (\Delta F_{Ca} - \Delta F_{Fe})$$

to which the free energy term has been added. Hence, in the quest for other suitable de-sulphurising elements, it is necessary to seek for those which show differences between the free energies ($\triangle F$) of formation of the oxides and sulphides, which are as large as possible, *i.e.*, $\triangle F$ (sulphide) $-\triangle F$ (oxide), should be as small as possible or negative.

Unfortunately, very few data exist for such free energy changes at high temperatures, but from such as there are for Ca, Mn, Fe and Cu it is evident that their free energy changes during the formation of the sulphides from the oxides is the same as the order of their heats of reaction ($\triangle H$). This is readily understood when it is appreciated that the difference between the free energy change and the heat of reaction is determined by the entropy change, which is similar for all cases, being largely governed by the substitution of oxygen by sulphur.

Table I shows the best that can be done at the moment in assessing the desulphurising powers of most elements, *i.e.*, by comparison as the heats of formation at 25 deg. C. of their oxides and sulphides.

TABLE I.—*Relative De-sulphurising Power of Various Elements.*

Element.	Δ H (Sulphide) — Δ H (Oxide)
Caesium	— 10 kilocalories
Rubidium	— 10 ,,
Potassium	— 2 ,,
Sodium	+ 30 ,,
Barium	+ 45 ,,
Strontium	+ 55 ,,
Nickel	+ 70 ,,
Calcium	+ 75 ,,
Manganese	+ 80 ,,
Iron	+ 81 ,,
Magnesium	+125 ,,
Beryllium	+180 ,,
Aluminium	+190 ,,

From Table I it will be seen that the alkali elements caesium, rubidium, potassium and sodium would seem to be the most promising. The compounds of the alkali metals, however, tend to be volatile at iron-melting temperatures, and it is probable that the full de-sulphurising effect of sodium carbonate is partially lost in normal practice owing to its volatility. The next group of elements which might be employed is the alkaline earth group (Ba, Sr, Ca, Mg and Be), and it is observable from Table I that it would be expected that the de-sulphurising tendency would progressively increase with rising atomic weight in that series. Barium thus stands out as possible, particularly as its cost is not high, and experiments were therefore made with a slag containing barium. The well-recognised affinity of the element nickel for sulphur is shown in Table I, but it should be pointed out that, whilst its specific affinity for sulphur as compared with oxygen is high, nickel is relatively a noble metal in that its actual affinity for both oxygen and sulphur is of a low order.

So far it has been assumed that sulphides only are formed, but it is known (and it was particularly confirmed from these experiments) that some sulphur dioxide is passed into the atmosphere during de-sulphurisation, so that the chain of reactions,

$$\text{Sulphide} \rightarrow \text{Sulphate} \rightarrow \text{Gaseous } SO_2,$$

may under some circumstances be all-important. A very stable sulphate would mean that the sulphide concentration in the slag, say (CaS), would be lowered at the slag/gas interface. On the other hand, an unstable sulphate might lead to the ready transfer of sulphur as SO_2 to the atmosphere, so that de-sulphurisation would be favoured. From such limited data as are available, it would appear that with the reducing conditions prevailing in contact with molten iron, very little sulphide would be oxidised to sulphate and that under the oxidising conditions of atmospheric air, an appreciable amount of any sulphide would be oxidised and dissociated, liberating SO_2. Thus, for optimum de-sulphurising, the somewhat conflicting requirements are reducing conditions at the slag/metal interface and oxidising conditions at the slag/air interface. In a static state these conditions do prevail, but the problem then is how to transfer the sulphide up through the slag. The Authors have sought to fulfil the desired conditions by bubbling through the bath an inert or reducing gas (N_2 or NH_3) in insufficient quantity to make the general slag/air interface reducing.

Experimental Procedure

To increase the experimental flexibility and so as to be able to make trials which might have spoilt the iron for subsequent commercial purposes, tests were made on a small scale in a twenty-pound high-frequency laboratory furnace as well as in a 45-cwt. ladle in a works. This expedited the work and made it possible to confirm, on a practical level, results previously indicated on a small scale, whilst, of course, it was recognised that a strictly quantitative comparison was not possible. As far as was possible, the experimental conditions were kept uniform and similar for the two series of tests. A basic-lined ladle was used for the works' trials and a

TABLE III.—*Group A. Lime/Alumina/Silica Slags.*

Expt. No.	Scale.	Slag materials. CaO. Per cent.	Al_2O_3. Per cent.	SiO_2. Per cent.	Gas.	Initial sulphur. Per cent.	Final sulphur. Per cent.	Percentage sulphur removed.	$\frac{S_S}{S_M}$
A.18	Lab.	58.4	33.3	8.3	N_2	0.184	0.172	6.5	2
A.19	Lab.	52.0	41.3	6.7	N_2	0.154	0.057	63.2	56
A.20	Lab.	42.0	14.0	44.0	N_2	0.160	0.129	19.4	7

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basic crucible was used in the furnace body for the laboratory trials. Temperatures were difficult to measure owing to presence of the slag and the complications caused by the gas bubbling, etc., but the immersion pyrometer was frequently used and the temperature range during the de-sulphurising operation was found to be between 1,360 and 1,300 deg. C., there being a temperature decrease of about 50 deg. C. The works control of its cupola metal was such that its temperature was very uniform, and comparable temperature conditions were striven for in the laboratory trials. The small H.F. furnace was of 10,000 cycles frequency, and it was found that it was necessary to maintain some power on the furnace in order to maintain the desired temperature, and there was in consequence some swirling movement in the bath.

The works' cupola metal contained about 3 per cent. of carbon, 1 per cent. of silicon, 0.4 per cent. manganese, 0.04 per cent. phosphorus, and 0.1 per cent. of sulphur. For the laboratory trials "Warner" white iron was melted down, and in consequence the silicon content of the melt was only about 0.2 per cent., whilst the sulphur content, which was introduced by an iron sulphide addition, was somewhat higher at about 0.15 per cent. Several of the laboratory trials were performed in sequence, *i.e.*, after one de-sulphurisation iron sulphide was added to re-establish the initial sulphur content and a second de-sulphurisation was made.

For the works' trials the standard procedure was to tap the cupola metal into a ladle containing 1.5 per cent. of the metal weight of slag-making materials. For the laboratory trials this was too small a quantity of slag to manipulate, and these trials were standardised on twice this amount, *i.e.*, 3 per cent. of slag-making materials. Numerous slag analyses were made from which it was found that the final slag normally contained about 1 per cent. of sulphur. Detailed slag analyses are not given in this Report for reason of space, and the fact that the analyses confirm that the slag composition is defined or is deducible from the slag-making materials. As would be expected, the slag analyses showed that, by reason of silicon oxidation from the bath, the slags were rendered less basic than the slag-making additions would have indicated. In calculating the sulphur distribution between slag and metal it was assumed as a first approximation that the weight of the slag was equal to the weight of slag-making additions. To prevent oxidation of the metal during melting down in the laboratory furnace a portion of the slag-making additions was added before melting had commenced.

The experiments can be classified into two types as follows:—

Group A.—Those in which nitrogen or ammonia was bubbled through the slag, which was kept fluid and basic by the additions to it of various materials, such as fluorspar and alumina.

Group B.—Those in which various additions were made to the molten metal with the express object of revealing any specific de-sulphurising effects.

Thus between these two groups of experiments it was possible to distinguish between the various operative factors such as the agitative and chemical reducing effect of gas bubbling. The nitrogen or ammonia was blown through a mild-steel pipe at the depth of the metal/slag interface, the operation lasting about ten minutes, and consuming 25 cub. ft. of gas for the works' experiments, and lasting 20 minutes and consuming 5 cub. ft. of gas for the laboratory experiments. The factor controlling the rate of gas flow was violence of the agitation produced, and the duration of the bubbling was determined by repeated metal analyses at intervals in a few of the initial experiments until the sulphur content was steady.

The results from the various experiments are presented in Tables II to VI.

Discussion of Results

Although many more experiments have been made than are reported here, the number of variables which were difficult to control was such that a large number of experiments were deleted from consideration. Even so, the Authors are only too conscious that the results which have been submitted for consideration are far from being conclusive, and much more work is indicated as being desirable. From the initial experiments with nitrogen bubbling, in which repeated samples were taken at intervals of a few minutes for about three quarters of an hour, it was found that the sulphur contents fairly rapidly settled down to the figures reported, thereby showing how the sulphur removal was not proportional to the volume of nitrogen bubbling. There was, however, a simultaneous temperature drop which complicated the interpretation of this result, and the Authors hope that later they may be able to make a study of the effect of gas bubbling under more uniform conditions.

TABLE IV.—*Group B. De-sulphurising agents added to the metal. Barium Carbonate with Sodium Carbonate or Fluorspar.*

Expt. No.	Scale.	Slag materials.			Initial sulphur.	Final sulphur.	Percentage sulphur removed.	$\frac{S_S}{S_M}$
		$BaCO_3$ Per cent.	CaF_2. Per cent.	Sodium Carbonate. Per cent.	Per cent.	Per cent.		
B.21	Lab.	100	—	—	0.158	0.084	46.9	30
B.22†	Works	84	16	—	0.111	0.060	46.0	115
B.23	Works	50	—	50	0.100	0.047	53.0	76
B.24	Works	50	—	50	0.092	0.052	41.2	51
B.25*	Works	33	—	67	0.095	0.037	61.0	105

* Re-poured into a second basic ladle after tapping. † ¾ per cent. slag only.

Whilst additions of barium carbonate show little beneficial action, it should be pointed out that barium added in the form of its carbonate is far from being the most suitable form for such an addition. Not only is the carbonate only partially dissociated at the experimental temperature, but the liberation of carbon dioxide from it was an unfavourable oxidising influence. Unfortunately, the carbonate was the only compound available which could be used; such compounds as chloride, which were also available, would most likely have introduced other objectionable features.

The outstanding results achieved with calcium nitride the metal to the slag, and that slag fluidity and intermixing with the metal are all-important.

(4) The rôle of nitrogen when bubbled through the slag appears to be solely that of a mixer of slag and metal, and no de-sulphurising action proportional to the volume bubbled has been observed.

(5) The most favourable de-sulphurising process so far tried has incorporated all the above factors, including chemical basicity and state of reduction together with intermixing, and was obtained by the addition of about equal weights of limestone and calcium nitride, whereby there was a violent liberation of gas *in situ*.

TABLE V.—*Calcium Carbide with Sodium Carbonate (and Fluorspar).*

Expt. No.	Scale.	Slag materials.			Initial sulphur.	Final sulphur.	Percentage sulphur removed.	$\frac{S_S}{S_M}$
		Sodium carbonate. Per cent.	Calcium Carbide Per cent.	Calcium Fluoride Per cent.	Per cent.	Per cent.		
B.26*	Works	100	—	—	0.127	0.032	74.8	197
B.27*	Works	93	7	—	0.136	0.025	81.6	294
B.28*	Works	93	7	—	0.100	0.025	75.0	200
B.29*	Works	89	11	—	0.114	0.023	79.9	264
B.30*	Works	89	11	—	0.144	0.038	87.5	186
B.31*	Works	82.5	17.5	—	0.117	0.030	74.4	193
B.32*	Works	82.5	17.5	—	0.076	0.030	60.5	102
B.33	Works	73.5	26.5	—	0.110	0.052	52.7	75
B.34*	Works	73.5	26.5	—	0.106	0.030	71.9	170
B.35	Works	73.5	26.5	—	0.096	0.034	64.6	122
B.36	Works	61.0	31.0	9.0	0.134	0.056	58.2	93
B.37*	Works	61.0	31.0	9.0	0.123	0.052	57.9	91

* Re-poured into a second basic ladle after tapping.

TABLE VI.—*Miscellaneous Results (Calcium Nitride, Aluminium, etc.).*

Expt. No.	Scale.	Slag materials.			Initial sulphur.	Final sulphur.	Percentage sulphur removed.	$\frac{S_S}{S_M}$
		Sodium carbonate. Per cent.	Aluminium. Per cent.	Other items Per cent.	Per cent.	Per cent.		
B 38*	Lab.	—	—	40 per cent. limestone, 60 per cent. Ca_3N_2	0.236	0.011	95.5	1,000
B.39	Works	95.5	4.5	—	0.096	0.044	54.0	78
B.40	Works	95.5	4.5	—	0.085	0.052	38.9	43
B.41	Works	95.5	4.5	—	0.104	0.045	56.7	88
B.42	Works	86	—	14 Ca/Al alloy	0.108	0.026	76.0	210
B.43†	Works	86	—	14 Ca/Al alloy	0.095	0.050	47.4	60

* 2 per cent. of slag. † Some acid slag entered ladle during tapping.

suggests that other such compounds, likely to lead to the presence of nascent and highly active metals, should be examined.

Conclusions

The following conclusions can be drawn from this preliminary enquiry, and these will act as a basis for future research:—

(1) It is confirmed that chemically basic and reducing conditions are favourable for de-sulphurisation.

(2) It is shown that a highly basic calcium silicate slag is effective as a de-sulphurising medium provided fluidity is maintained by fluorspar or other additions.

(3) It would appear that the predominant controlling factor is the mechanism of transfer of the sulphur from

Acknowledgments

The Authors wish to thank those who have provided facilities for the conduct of this work, namely Mr. J. L. Harrison (Catton and Company, Limited, Leeds), Dr. A. H. B. Cross and Mr. Holt (Thomas Firth and John Brown, Limited), and Mr. G. E. Speight (United Steel Companies, Limited). They thank also the Melting Sub-Committee (under the Chairmanship of Mr. R. Lamb) for its general guidance upon the work, and to their colleagues in the British Iron and Steel Research Association (especially to Dr. F. D. Richardson and Mr. A. Hartley) for assistance in various ways.

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4 Private communications SM/A/8/46 and SC/AA/60/47.

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DISCUSSION

MR. D. FLEMING (Bury) said that on reading the paper one might perhaps be forgiven if one's first reactions were to feel that the term "new methods" in the title was optimistic, and to feel that the paper contained little which advanced beyond the practical and theoretical position as it existed when Sub-Committee T.S.10 of the I.B.F. produced its 1947 Report. It would not have been very surprising if a research team, on taking over a project from foundrymen who worked under works' conditions, had not done more in their first year's work than to confirm certain of the data presented to them, merely clarifying and reinforcing it by virtue of repetition under more accurately controlled conditions. All the new materials tried in the next stage of their work could well have given results inferior to the best previously reached, as, indeed, most of them appeared to have done on the evidence presented in the Paper.

One result alone, however, was sufficiently significant to repay the team for much solid work, and to justify their claims to something "new." The comments made about that result, as if in partial explanation, dismayed the speaker, however, especially when taken in conjunction with the remarks on Dr. Heuer's process.

Desirability of Equilibrium Conditions

There were dangers in predicting the results of metallurgical operations from simple equations which were only valid under equilibrium conditions, and erroneous conclusions would be drawn unless equilibrium conditions could be closely approached. For a variety of reasons, steps had generally to be taken to assist that approach. In a simple laboratory titration, one did not wait for the slow diffusion of each addition made; one stirred or shook the solution to which the addition was being made. When "washing" metal with a slag one could not afford to await the slow diffusion of impurity and reactant to the slag-metal interface and of the products away from that interface, assisted only by convection currents; especially was that true of most ladle reactions, for time was precious when valuable heat was being dissipated into the surrounding atmosphere. Any means which assisted the speeding up of contact between all parts of the metal and all parts of the slag were thus obviously valuable. Therefore he agreed that slag fluidity and inert gas bubbling were "controlling factors"; tall vessels providing a long drop for the pouring stream, and mechanical stirrers, had also been suggested in previous work; to those might be added vessels rotating about a horizontal axis, the use of metal pumping by the application of suitably disposed electrical fields, and counterflow of thin metal and slag streams.

Ameliorating Sulphur Reductions

Following equation (i) in the third paragraph of the paper, ($FeS + CaO \rightleftharpoons FeO + CaS$), he said the deduction was made that

$$\frac{S_S}{S_M} = K \times \frac{(CaO)}{[FeO]}$$

He generalised that for all possible desulphurising reactions as follows :—

$$\frac{\text{Concentration of S in slag}}{\text{Concentration of S in metal}} = K \frac{\text{Concentration of de-sulphurising reactant in slag}}{\text{Concentration of end product in metal.}}$$

Remembering that only equilibrium conditions were covered by such equations, it could be deduced that the degree of sulphur removal would be improved by: (*a*) Increasing the ratio of slag weight to metal weight; (*b*) Using slags with high percentages of the active reactant; (*c*) choosing reactions with high K values; and (*d*) lowering the concentration of the end product in the metal.

Method (*a*) was well known and was amply evidenced by Mr. D. Joyce (Consett), who had reduced the sulphur in a hæmatite iron from 0.023 to >0.009 per cent., using 20 per cent. soda ash! Method (*b*) could be illustrated by examples from the Paper. Method (*c*): high K values were probably to be found associated with compounds which locked the sulphur in the slag in a very stable form as second order compounds.

Methods (*a*), (*b*) and (*c*) had all some limiting factor, such as expense, heat loss to slag, loss of slag fluidity, etc., which prevented exceedingly high degrees of sulphur removal being practised. Drawing attention to method (*d*), he said that as the concentration of the end product in the metal approached zero, so did the ratio $\frac{C \text{ of } S_S}{C \text{ of } S_M}$ approach infinity.

Calcium Nitride

The highest efficiency shown in the Paper was undoubtedly that obtained when using limestone and calcium nitride.

The relevant equations were presumaby :—

(i) $Ca_3N_2 + 3FeS \rightleftharpoons 3CaS + 3Fe + N_2$.
(ii) $CaO + FeS \rightleftharpoons CaS + FeO$.
(iii) $Ca_3N_2 + 3FeO \rightleftharpoons 3CaO + 3Fe + N_2$.

Of those, (ii) and (iii) could be summated to yield form (i) occurring in the presence of lime.

Equation (i) could be transposed to the form :

$$\frac{S_S}{S_M} = KX \frac{(Ca_3N_2)}{[3Fe]\, PN_2}$$

where the partial pressure of the nitrogen in the iron became the controlling factor.

That gave a direct analogy to the equations cited for the process of Dr. Heuer.

$$\frac{S_S}{S_M} = KX \frac{(CaO)\, C}{[Fe]\, P_{CO}}$$

Surely it was significant that those two reactions had had claimed for them higher S_S/S_M ratios than any other published reactions. (Heuer 8000 : 1 & Ca_3N 1500 : 1).

He urged strongly that future work should be directed to reactions which gave a gaseous end-product in the metal, the partial pressures of which could be reduced to a low value, or to reactions which gave a

metal end-product in the iron (the latter surely being the mode of operation of such additions as metallic calcium, magnesium, etc., which were strongly reducing and had strongly basic oxides). By such means very low residual sulphurs would appear to be attainable with high efficiencies. Was not the major reason for the desirability of reducing conditions the fact that such conditions lowered the oxide concentration in the metal in reactions where the normal limiting factor was the iron oxide concentration resulting in the metal?

Mr. Fleming suggested that the reasoning of Dr. Heuer was sound, and that the principle should be re-examined. With regard to the Authors' remark that "there are sources of FeO other than the main reaction," he said those sources were surely limited and could thus be virtually exhausted. Finally, he complimented the Authors on their work and wished them every success in their future efforts in a field which was of vital interest to all ferrous foundrymen and bade fair to be of increasing importance in the future.

DR. NEWELL, replying, welcomed the critical comments made by Mr. Fleming, and said that he and his colleagues would apply them. Commenting on the methods mentioned by Mr. Fleming, he said there was nothing new under the sun; the Authors had merely tried things in a new way. It all pointed to the fact that the work done previously by the Institute and its T.S.10 Committee was admirable; it had laid the foundation for the work discussed in the Paper.

Agitation Helpful

The work did show that gaseous products were helpful in agitating the metal, but there was the question of diffusion of materials within the liquid metal. Theoretically, diffusion was a slow process, even with liquid steel at high temperatures. It was abundantly shown that a small amount of agitation or convection could alter the conditions thus arising from the bulk movement of the metal; and the fact that a small amount of calcium nitride had a great effect in a short time indicated that there must be a considerable bulk movement of the metal.

There had been the same line of reasoning regarding steel-making processes; processes which might occupy several hours in relatively static conditions in the open hearth might be accelerated considerably by agitation, as in the high-frequency furnace. Also it was known that the deoxidation of steel could be effected very rapidly if the deoxidants were added to the liquid steel whilst it was being poured into the ladle. With deoxidation, also, it was found that metallic additions which dissolved in the liquid steel were most effective. It would appear that de-sulphurisation should similarly be performed by violently stirring into the steel a soluble metallic addition.

Use of Green Wood

MR. D. E. CATTON (Leeds) mentioned a simple method of agitation which was found to be of very great benefit at his works in the de-sulphurising of liquid iron. It was not new, because the suggestion was made earlier by the Ford Motor Company, of Dagenham. It consisted of introducing into the ladle a piece of green wood, which gave rise to considerable agitation, eliminating the necessity for introducing mechanical means. He believed Dr. Newell was aware that that method had given considerable help in the percentage reduction of sulphur.

Mr. N. L. EVANS wrote, this Paper will prove valuable as an independent review of the subject of the ladle de-sulphurisation of pig-iron, and the Authors are to be congratulated on the ground they have covered and the interesting suggestions put forward for new reagents. The results obtained emphasise the following points: (1) The necessity for a fluid slag; (2) the necessity for a high degree of basicity; and (3) the necessity for agitation.

The spectacular degree of de-sulphurisation attained by the use of calcium nitride is interesting mainly as a laboratory curiosity. The reagent is not a commercially produced chemical, and under present conditions it is hardly likely that its manufacture can be undertaken on a scale and at a cost which would bring it into general use in the iron industry.

As regards the Heuer process, the results have been disappointing, but this is not surprising, as there exists a considerable volume of evidence that, at the temperature of molten iron, the presence of silica is a hindrance to de-sulphurisation. This is shown in the work done on de-sulphurisation in basic lined ladles[a]; among the causes of erratic results when treating iron with sodium carbonate, G. S. Evans[b] lists blast furnace slag, entrained silicates and dirty ladles; and German investigators[c] have noted that less sodium carbonate is required for de-sulphurisation after the mixer than between blast furnace and mixer owing to the absence of siliceous slag.

Doubtful Value of Blast Furnace Slag

Heuer recommends the use of blast furnace slag—surely a most undesirable reagent, as it may contain 2.5 to 4 per cent. of sulphur initially—rendered more basic by the addition of lime and more fluid by the addition of fluorspar; and he proceeds to introduce agitation by blowing nitrogen through the iron or into the slag/metal interface. All these results can be obtained by the use of sodium carbonate alone, or, in certain special circumstances,[d] sodium carbonate with limestone. Sodium carbonate is highly basic, has a low melting point (851 deg. C.), forms a very fluid slag, and evolves carbon dioxide gas at iron melting temperatures. It is significant in the Paper that sodium carbonate by itself gave excellent de-sulphurisation, and when it was added to other reagents tried, it frequently improved the fluidity of the slag and increased the degree of de-sulphurisation.

The function of agitation is twofold. In the first place it assists the intimate contact between slag and metal, and secondly, it continually exposes a fresh slag surface to the atmosphere, thus encouraging the removal of sulphur from the slag by oxidation to sulphur dioxide. These processes continue after the ladle has been filled, but another factor which is of paramount importance is the agitation caused by rapid

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pouring of the metal. Labeka and Walker[e] have shown that, under comparable conditions of de-sulphurisation with sodium carbonate, the average de-sulphurisation was 34.3 per cent. when 5 mins. or less was required to fill the ladle, and only 27.5 per cent. when this took 6 mins. or more.

Reverting to the question of siliceous slags, a Paper by Durred and Marincek[f] is of interest. This shows that de-sulphurisation with such slags depends on the formation of silicon sulphide, a gaseous product, but a temperature of 1,600 to 1,800 deg. C. is required, which entirely rules the process out for the de-sulphurisation of pig iron.

The statement in the Paper that calcium silicate "is effective as a de-sulphurising medium" does not appear to be adequately supported by the results. The suggested addition of fluorspar in this and other cases may be effective in promoting fluidity in the slags, but the well-known destructive effects of the halogen compounds on refractories is likely to prevent the widespread use of fluorspar, which is, in addition, frequently contaminated with silica.

Further Research Advocated

In conclusion, the writer feels most strongly that, for the practical de-sulphurisation of pig iron, sodium carbonate provides the simplest, the most straightforward and the cheapest solution to the problem, but it is essential, if results are to be improved, to pay attention to the following points:—

(1) Sand, blast furnace slag, and other sources of silica must be, as far as possible, eliminated as contaminators of the basic slag. It seems a pity that on an elaborate and expensive blast furnace plant such details as the runner (usually loose sand) and the slag traps should not have more attention devoted to them.

(2) A suitable basic lining must be devised for ladles of 25 tons capacity and upwards. It has been demonstrated that a water bonded, rammed basic lining is not sufficiently durable, and either fired bricks or a tar-bonded monolithic lining will be required. But until someone who has the facilities for doing so decides to try this on a sufficient scale, the answer will remain a matter of speculation.

(3) The economics of the de-sulphurising process can only be judged by the cost of the finished ingot, and interdepartmental competition as regards costs should be disregarded and attention focused on total costs. For example, the expenditure of an additional shilling or so per ton of iron on basic ladle lining may well prove to be a worth-while economy if, by reason of the lower sulphur and silicon contents of the iron, the slag volume and the time necessary for refining it in the steel furnace can be reduced. Again, it must be emphasised, the answer will not be known until the experiment is carried out on a works scale.

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c Report No. 191. Blast Furnace Committee of Verein Deutscher Eisenhüttenleute. See The Iron Age, Apr. 9, 1942, pp. 45-48.

d Colclough. "The Brassert Process for Acid Burdening the Blast Furnace." Iron & Coal Trades Review, CXXXV, Sept. 3, 1937.

e "De-sulphurisation of Molten Iron with Soda Ash." Am. Inst. Min. & Met. Eng. Blast Furnace and Raw Materials Committee. Proc., Vol. I, pp. 68-91.

f "Desulphurisation by means of Acid Slags." Stahl. u. Eisen, June 25, 1942. See Iron & Coal Trades Review, Oct. 23, 1942, pp. 1023-4.

Publications Received

Atlas Wad Odlewniczych [Atlas of Foundry Defects]. Compiled by Professor K. Gierdziejewski, of the Kracow Technical High School.

This brochure carries about thirty-five illustrations of classified defects in castings. Beneath are given in a number of languages the type of defect illustrated. In a few cases, space is left for a suitable picture, when one can be found. The whole subject is presented according to a logical classification. Poland is the third nation to produce an Atlas.

The Directory of Quarries, Clayworks and Sand and Gravel Pits. Published by the Quarry Managers' Journal, Limited, Salisbury House Square, London, E.C.4. Price 10s. 6d.

This directory in its first section lists, in alphabetical order, subdivided as to quarries, clayworks and sand and gravel pits, all the concerns engaged in winning these minerals. Next, with the same subdivisions, there is a geographic listing. The final part comprises a list of quarries and pits classified according to main products. Surprisingly, there is no list of moulding-sand pits. The alphabetic and geographical lists are commendably complete.

Dolomite and Refractories. Published by the Steetley Company, Limited, Shireoaks, Notts.

Never, even in pre-war days, have the metallurgical industries produced a higher standard of trade publication than the one under review. Especially fine are the reproductions of paintings by Mr. Henry Rushworth, R.A. He is probably at his best with a picture of Steetley Chapel, while at the other end of the scale the reviewer would place the illustration of the lining of an open-hearth furnace. The general level, however, is no less than brilliant. The letterpress has been written by Mr. Douglas Wilson, and he has given a lucid description of the history of basic refractories; the various works in the Steetley organisation and the processes used. Be it noted that the ground basic as received by the steelworks is *doloma*. It is the correct word and should be used instead of the several loose appellations now current. The brochure, which measures 12 in. by 10 in., runs to 30 pages and carries 14 of Mr. Rushworth's paintings.

The Application of Oxygen Enrichment to Side-Blown Converter Practice*

By J. L. Harrison, F.I.M., W. C. Newell, Ph.D., D.I.C., A.R.C.S., F.R.I.C., and A. Hartley, B.Sc.

From experience gained during several months' continuous operation with oxygen-enriched heats, the Authors are satisfied that even a moderate degree of oxygen enrichment applied with little or no modification to existing converter units, can lead to an improvement in steelmaking practice. The fact that a closer degree of control can be gained in this steel-making operation is a feature of value, which should favourably influence the future application of the side-blown converter. The Authors would not put undue significance upon the shortening of the blowing operation for the average foundry, where melting capacity is generally adequate, but they would suggest that larger furnaces of this type might, with oxygen enrichment, be employed for bulk ingot-steel production, especially in basic-lined vessels. At the same time, the significance of higher steel temperatures to a foundry requiring only small quantities of steel intermittently is obviously an attractive feature, especially where thin-section castings are being made and greater fluidity is desired.

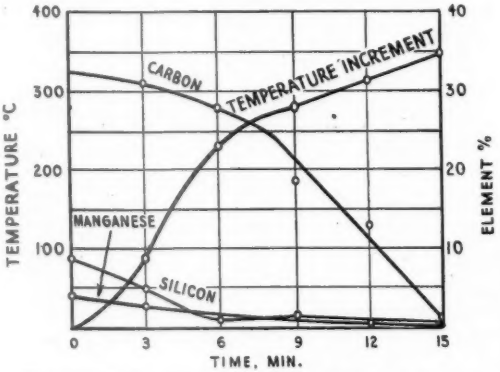


FIG. 1.—GRAPH SHOWING THE CHEMICAL CHANGES OF THE BATH AND TEMPERATURE INCREMENT, DURING NORMAL SIDE-BLOWING OPERATIONS.

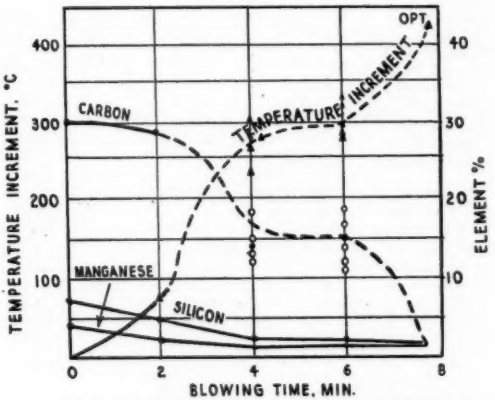


FIG. 2.—GRAPH SHOWING THE CHEMICAL CHANGES OF THE BATH AND TEMPERATURE INCREMENT USING OXYGEN-ENRICHED AIR CONTAINING 35 PER CENT. OXYGEN, IN A SIDE-BLOWN CONVERTER.

Blowing Loss

The fact that under normal operating conditions with air blowing, such a large excess of air being passed through a side-blown converter has not been reported before, as far as the Authors are aware, and the fact that oxygen enrichment so markedly increases the efficiency of the oxygen reactions, is an additional factor of merit. This is in accord with the higher oxygen efficiency reported by Kondakov[1] for bottom-blown converters. The apparent reason for this is that normally the high blowing rate, necessary for reasonably rapid completion of the heat, is too high for complete chemical reaction with the bath. This point is intimately linked up with the blowing loss; normally the blowing loss is the dominating factor limiting output, but by reducing the rate of blast flow through the converter the blowing loss can be substantially reduced, as shown by these trials. Clearly, therefore, blowing loss is not so much dependent upon rate of oxidation as upon rate of efflux of gas from the converter, though in this connection it should be pointed out that carbon monoxide (or dioxide) has also, of necessity, to pass out as a gas from the vessel, and with the trials made in which the oxygen content was varied to stabilise

* Extracted from a Paper SC/AA/4/48 of the Melting Sub-Committee of the Melting and Metallurgical Committee of the Steel Castings Division of the British Iron and Steel Research Association. The views expressed are the authors, and are not necessarily endorsed by the committee as a whole. Mr. Harrison is with Messrs. Catton & Co., Ltd. Dr. Newell and Mr. Hartley are with the British Iron and Steel Research Association, London.

Application of Oxygen Enrichment

the rate of the carbon reaction, the blowing loss was abnormally low.

In normal side-blown converter practice it is found that the carbon oxidation only proceeds with rapidity when the bath has reached a temperature of over 1,400 deg. C., and it is a generally accepted idea that the main function of the silicon is to raise the temperature of the bath, by oxidation, to this requisite temperature. This phenomenon is well shown in Fig. 1. However, with oxygen enrichment and in the absence of silicon, the carbon combustion proceeds quite rapidly even at low temperatures. The probable explanation of this is that the oxygen enrichment has so accelerated the carbon combustion that it is sufficiently high even at the low temperatures. Theoretically it should proceed throughout the possible temperature range, but elevation in temperature should accelerate the combustion.

An Unusual Phenomenon

After the carbon combustion has proceeded about half-way and with a temperature increment of 200 to 300 deg. C., the carbon reaction and temperature tend to become stationary for a period. This is a remarkable fact, which it is not easy to explain (see Fig. 2). As has been pointed out, the same effect can be seen from the normal air-blown heats to a slight extent, though it must be admitted that no significance had previously been attached to this. One explanation of this phenomenon is that at this stage the slag passes through a viscous and sluggish condition, so that oxidation is hindered. The great variation in the oxygen efficiencies at the different stages of the blow (see Table I), lends support to this idea, as does also the fact that raising the oxygen content at the sluggish period (see Table II) results in a poor oxygen efficiency.

Probably by reason of the high temperature attained by these trials, the silicon is not so completely oxidised, or, alternatively, there is some reversion of silicon back to the bath from the silica of the slag. The average effect would appear to be an increment of 0.05 per cent. of silicon, which means some economy in the quantity of deoxidants to be added.

Economic Aspects

A consideration of the economic aspects of oxygen enrichment is a rather complex matter. The cost of adding 1,000 to 2,000 cub. ft. of oxygen per ton of steel must be set against a series of factors, such as enhanced fluidity and higher output or shorter working day, which will vary in value with different works. But apart from these factors, economies in materials, including cupola fuel, pig iron, ferro-silicon, and blowing loss, are commensurate with the probable ultimate cost of oxygen of suitable or "tonnage" quality, as it is known.

TABLE I.—*Details of Heats which were Interrupted Before the Blow was Completed* (2,000 *Cub. Ft. per Min. of* 35 *per cent. Oxygen-Enriched Air*).

Cast No.	Duration of blow before interruption, min. sec.	Total oxygen used*/ (theoretical oxygen).	Cupola metal composition. C, per cent.	Si, per cent.	Mn, per cent.	Composition of Bath at interruption. C, per cent.	Si, per cent.	Mn, per cent.	Weight of cupola metal, cwt.	Cupola-metal temperature (immersion), deg. C.	Bath temperature, deg. C. Optical.	Immersion.	Temperature increment, deg. C.
602	2.00	3.30	3.05	0.76	0.41	2.89	0.53	0.31	44	1,375	—	1,435	60
603		2.83	2.98	0.69	0.36	2.82	0.36	0.21	44	1,365	—	1,440	75
604		2.73	2.80	0.56	0.32	2.62	0.25	0.18	44	1,320	—	1,370	50
614		1.50	3.14	0.98	0.38	2.60	0.65	0.27	38	1,370	—	1,485	105
617		3.05	2.86	0.60	0.36	2.68	0.27	0.18	38	1,380	—	1,490	110
Average	.. ..	2.35	2.97	0.72	0.37	2.72	0.41	0.23	41¾	1,363	—	1,443	80
629	4.00	1.15	3.14	0.85	0.37	1.72	0.28	0.15	40	1,335	—	1,640	305
630		1.02	3.11	0.62	0.37	1.40	0.15	0.13	40	1,350	—	1,630	280
644		0.95	3.30	0.68	0.38	1.50	0.23	0.17	42	1,360	—	1,590	230
645		0.96	3.30	0.59	0.29	1.48	0.21	0.15	42	1,340	—	1,610	270
646		0.99	3.14	0.47	0.32	1.30	0.24	0.16	42	1,340	—	1,620	280
Average	.. ..	1.01	3.20	0.66	0.35	1.48	0.20	0.15	41½	1,343	—	1,623	280
978	6.00	1.43	3.22	0.50	0.33	1.59	0.15	0.11	46	1,335	—	1,650	315
980		1.14	3.30	0.61	0.38	1.25	0.18	0.21	46	1,310	—	1,620	310
39		1.77	3.15	0.72	0.56	1.84	0.16	0.22	42	1,300	—	1,590	290
40		1.77	2.82	0.72	0.62	1.48	0.24	0.20	42	1,315	—	1,600	285
Average	.. ..	1.42	3.12	0.64	0.48	1.54	0.18	0.18	44	1,315	—	1,615	300
585	9.36	1.33	3.03	0.69	0.39	0.10	0.29	0.11	44	1,395	1,780	—	385
589	7.56	1.23	2.82	0.61	0.39	0.08	0.14	0.08	42	1,400	1,810	—	410
595	8.05	1.11	2.96	0.57	0.41	0.08	0.11	0.09	45	1,365	1,800	—	435
596	8.35	1.23	2.90	0.59	0.41	0.08	0.09	0.07	44	1,380	1,810	—	430
597	8.00	1.25	2.70	0.46	0.33	0.09	0.14	0.11	44	1,370	1,790	—	420
Average	8.26	1.23	3.00	0.64	0.38	0.08	0.15	0.09	44	1,382	1,798	—	416

* In this table it has been assumed that no iron has been oxidised from the bath.

TABLE II.—*Details of Heats Blown with Oxygen-Enriched Air at a Total Rate of Flow of 2,000 Cub. Ft. per Min., but with Oxygen Raised from 30 per cent. to 35 per cent. After 4 Min. Blowing.*

Cast No.	Duration of blow, min., sec.	Volume of oxygen added, cu. ft.	Total volume of oxygen used, cu. ft.	Total oxygen derived from oxygen addition, per cent.	Total oxygen used/ (theoretical oxygen).	Composition of cupola metal.			Composition of blown metal.			Weight of cupola iron, cwt.	Blowing loss, per cent.	Temperature, deg. C.		
						C, per cent.	Si, per cent.	Mn, per cent.	C, per cent.	Si, per cent.	Mn, per cent.			Cupola metal (immersion).	Final bath (immersion).	Increment.
563*	8.10	2,600	5,400	48	1.40	2.63	0.80	0.51	0.08	0.04	0.07	39	3.2	—	1,750	—
564*	8.30	2,800	5,900	47	1.43	2.70	0.63	0.47	0.13	0.08	0.12	39	3.9	1,390	1,740	350
571	7.45	2,500	5,100	49	1.22	2.63	0.50	0.42	0.07	0.10	0.13	40	11.2	1,335	1,710	375
572	8.44	2,700	5,900	46	1.41	2.65	0.61	0.43	0.08	0.15	0.13	40	5.1	1,345	1,720	375
573†	11.10	3,200	7,100	45	—	—	—	—	—	—	—	40	8.1	1,340	1,740	400
574	7.43	2,600	5,800	45	1.28	2.84	0.71	0.39	0.10	0.17	0.08	40	13.7	1,380	1,730	350
Average	8.40	2,730	5,870	46.5	1.36	2.69	0.65	0.44	0.09	0.11	0.11	39¾	7.5	1,360	1,730	370

* The blowing-loss figures are obviously too low but indicate small loss. † First heat of day.

As yet the side-blown converter process is used predominantly for making carbon steel and manganese steel (the manganese being added in molten form), but the higher temperatures obtainable with oxygen enrichment open up the possibility of making substantial cold additions to the blown carbon-steel base, so that it should be practicable to make higher alloy steels by this process. Trials are shortly to be made upon this proposal.

Conclusions

It is concluded that oxygen enrichment of the side-blown converter blast is likely to be widely applied in the future on account of the following technical advantages which have been demonstrated in this report, namely:—

1. Higher steel temperature is possible, with its attendant advantages in the foundry of increased fluidity and reduced skulling loss.
2. A shorter blowing cycle is possible, thus permitting a higher steel output from a given plant or, alternatively, a smaller plant for a given output.
3. Lower molten-iron temperature can be accepted thus permitting some fuel economy in the cupola.
4. A higher-scrap charge may be used in the cupola, thus permitting a reduced pig-iron consumption.
5. Reduction in the need for ferro-silicon addition during cupola melting or during the blowing operation.
6. Reduction in the blowing loss.
7. Easier control of the end-point and a more consistent final composition.

From experience gained during several months of continuous operation, the Authors are of the opinion that the side-blown converter with oxygen enrichment is likely to be increasingly used, not only in foundries for carbon and manganese steels, but also for bulk ingot-steel production.

This last suggestion would probably necessitate modfications in design in the light of the altered aerodynamic conditions inside the converter, as well as the use of basic lining in larger units.

Acknowledgments

The Authors wish to record their thanks to Mr. A. H. Catton and Mr. D. E. Catton for their support, interest, and encouragement, and to all members of the Steel Plant, Foundry, Laboratory, Maintenance and Drawing Office staffs of Catton & Company, Limited, for the assistance given. They also acknowledge willing assistance given by members of the staff of the British Iron and Steel Research Association, and by Mr. G. E. Speight, of The United Steel Company, Limited. The Authors also appreciate the help and co-operation of the British Oxygen Company, Limited, with regard to the supply of oxygen-control equipment.

REFERENCE

IV. V. Kondakov: Bulletin de l' Academie des Sciences de l' U.R.S.S. 1946, No. 10, pp. 1057-1067.

New Catalogues

Moulders' Leggings. A leaflet received from Safety Products, Limited, of St. George's House, 44, Hatton Garden, London, E.C.1, illustrates and describes a new line in asbestos leggings. There being no contact with the leg, the leggings are particularly cool to wear. The fastening is by spring clip.

Non-ferrous Melting Plant. Three folders have been received from the Monometer Manufacturing Company, Limited, of Clifton Drive, Westcliffe-on-Sea, Essex. Included in the plant illustrated and described are rotary and semi-rotary non-crucible tilting furnaces; central axis, lip axis, and lift-out crucible furnaces; bale-out melting furnaces; lead and white-metal melting furnaces; hot-metal receivers; tea-pot pour receiving ladle and a slag ladle. As a medium for publicity, the reviewer believes that folders are rarely one hundred per cent. satisfactory as difficulties arise in filing. This is especially true of serious plant such as is covered by this series, where there may be a time lag between their receipt and an urge to investigate the subject. They seem more suited for materials than machines.

British Standard 1452:1948 "Grey Iron Castings," has now been issued by the British Standards Institution, 24/28, Victoria Street, London, S.W.1, and costs 2s. 6d. post free. This specification has already been reviewed in our columns.

Repetition Pattern Making*

A Survey of Methods

(Slightly Abridged)

By K. L. Futter

It will be appreciated that the subject of patternmaking is one covering a very wide field in all its applications, and it is felt that some narrowing of this field is necessary for the purpose of this paper. It is proposed, therefore, to deal exclusively with patterns for light castings made on a repetition basis. Although the craft of patternmaking is one of the oldest in South Africa, it has been confined until recent years almost entirely to the construction of jobbing patterns, and it is difficult to persuade patternmakers to adapt themselves to this new type of work.

The high degree of accuracy required, the intricacy of most castings to be produced, and the monotony of close confinement to the bench, demand keen supervision and some planning of varying the work given to a particular man over a period. At the same time, once a patternmaker has adapted himself to the intricacy of the work, and the close limits of accuracy permissible, the work becomes fascinating and one of the most skilled of all trades.

Wood

Wood has been used for patterns ever since founding began, and is still widely used for small quantities and fairly plain jobs. One type of timber available to the South African patternmaker is yellow pine, which is cheap and effective where accuracy is not so important. It is soft, and easily worked either by hand or machine, and is valuable especially for the construction of master patterns and core boxes. Except for very small quantities, however, it is too soft for production patterns, and is therefore better replaced by mahogany or teak, if available. These timbers are harder close-grained woods, which, when well seasoned, are not so likely to warp or distort as are the softer timbers, and being harder will withstand the rough conditions of the foundry better. Where cost is the limiting factor, it is obvious that wood is the ideal material for patternmaking, and it has further the advantage of lightness, which means less fatigue for the moulder. Wood is also a popular material for core-boxes, especially on account of lightness, but when used, metal wearing strips should always be located on edges to be strickled, since wood wears quickly, due to the abrasive action of core sand.

Plaster of Paris

Plaster of Paris and a number of preparatory hard setting compounds can be moulded easily, and set, giving a hard stone-like finish. Their biggest disadvantage is brittleness and, whenever used in the foundry, they must be treated with great care. Perhaps their greatest use is as a material for irregularly jointed patterns, the procedure being the same as that adopted for the casting of metal cast plates, which method will be explained later. A point of big disadvantage for plaster work is the fact that jolting on a power moulding machine is virtually ruled out due to the fragile nature of the material. In the author's foundry considerable use is made of the plaster method for the production of small and intricate core-boxes and core carriers. For core-box production a master half core, or cores in the case of a multiple core-box, is made, suitable contraction allowance being made. These are mounted on a flat board and a frame is built around them to the required shape of the required box. This frame is filled with compound and when stripped is a pattern for the metal core-box, which is then cast usually in aluminium. For core carriers a similar procedure is used, except that usually these are made in cast iron to withstand the rough usage they are put through in the core-shop.

Metal Patterns

For large quantity production, particularly of intricate castings, metal patterns are essential, especially in a mechanised foundry. At the same time there is a considerable controversy as to which is the best metal to be used, and it is difficult to decide as to which is most suitable, and impossible to generalise. Each job must be considered in the light of its peculiarity.

Cast Iron

Probably the first metal to be used extensively for production patterns, cast iron has many advantages. It is tough and exceptionally hard wearing; if the original casting be of a really good finish, the abrasive action of moulding sand during use will actually improve the finish. For pattern plates for any form of jolt machine it is ideal because of its mass and because it withstands the continual bumping of the box better than anything else. On the other hand it is not easy to cast with a superfine finish, and is therefore ruled out for snap-flask work by reason of its weight. Hand working of the original casting is very difficult, and unless proper facilities for finishing are available in the pattern-shop, cast-iron patterns are likely to become very expensive, despite the relatively low cost of the raw material. In the event of repairs or small additions being necessary to a cast-iron pattern, this can be fairly easily accomplished by brazing.

Zinc Base Alloys

Zinc alloys have a number of advantages for production patternmaking, perhaps the chief among these being the ease with which they can be soldered. They will take a reasonable degree of polish and are fairly

*A Paper read before the South African Branch of the Institute of British Foundrymen, Mr. J. H. West presiding.

easily worked, but due to their very soft nature are easily bruised and damaged and they also corrode easily, so that care must be taken when zinc patterns are stored for any length of time.

Aluminium

Aluminium is used extensively in the author's foundry for patterns, and has a number of advantages. First, its extreme lightness, making it the ideal material for snap-flask work, where the pattern plate has to be handled by the moulder. It is easily worked up to a first class finish, and retains this without corrosion, almost indefinitely. It does not sweat and therefore is less likely to cause sand sticking in the foundry. On the other hand, aluminium is not an easy material to cast, and on flat surfaces has a tendency to warp, largely due to unequal cooling because of large risers necessary to produce soundness. A major disadvantage, however, is the fact that it is almost impossible to solder, and difficult to weld. Various methods of soldering aluminium patterns for repairs and damages received in the foundry, etc., have been tried with little or no success, as have various liquid solders, which have a limited application but eventually peel off and, like wax fillets, give endless trouble in the foundry due to sticking. While welding can be carried out with reasonable success, it has one big drawback in that it tends to warp the pattern or pattern plate, whichever the case may be, particularly the cast plates, and the brittle nature of the material makes straightening almost impossible. Even so, aluminium is used extensively for the production of all types of patterns, pattern plates, double sided plates and twin plates.

Brass

Brass is probably the more suitable material for production patternmaking, except where, due to its weight, aluminium, being lighter, is preferable. The high cost of the raw material rules out its use, except for exceptionally high precision work and where quantities run into many thousands. Brass takes an exceptionally high degree of polish, is sufficiently hard to give clear definition, but soft enough not to be easily broken. It can be sweated together and soldered very easily, and is the most easily hand worked of all pattern materials mentioned, except wood. Perhaps the greatest advantages of brass are its use for fabricated patterns where the whole or parts of a pattern layout can be fabricated, and casting eliminated. A symmetrical pattern, which can be made largely in the lathe, lends itself ideally to brass as a raw material.

The foregoing outlines the main advantages and disadvantages of materials largely used in pattern construction; although there are certain parts with which everybody will not be in agreement.

Pattern Making and Mounting

Before the construction of pattern equipment for production moulding is commenced, discussion with the foundry manager is of the greatest importance in deciding various points. Methods of jointing, coreing and core-box construction all depend on the material in which the resultant castings are to be made, and also on those materials having high liquid shrinkages, such as steel and low carbon irons, all this is of particular importance, and the peculiar experiences of the foundry manager in the founding of these are of great value.

The number of castings required will to some extent decide the number of patterns to be made, the size of the plate required, and perhaps the method of moulding. At the same time, the method of moulding is more largely determined by the nature of the job itself. For example, in the Author's foundry many jobs are mounted on stripping machines, which should be made either from stripping plate patterns or on small roll-over machines, simply because neither of these facilities is available. Similarly, with core-box production the material from which the box is made, whether a multiple box or if the core or cores are to be hand rammed or made by the core blower, can only be decided by quantities involved, cost of equipment, and the merit of the particular job. However, in each case a master pattern is necessary, together with a master core-box and shell carrier if these be required. These are made, as patterns have been made ever since founding began, by a master craftsman and invariably in wood, with the exception of the plaster master pattern, previously referred to. It is felt that for the purpose of this Paper, it is not necessary to dwell on the actual intricacies of the pattern making since a different subject entirely would be involved.

It might well be emphasised here, however, that the first essential to good patternmaking is to lay out the design full size on a smooth board, showing, if possible, one or two views which may not be included in the drawing, so that a really clear picture of the pattern to be produced may be obtained. This drawing should include all possible dimensions and should show pattern taper (assuming that a joint has been decided upon before commencement of the drawing). Core prints should also be shown and core-box jointing as well, if this is possible, since these will be of value for checking from the foundry manager's point of view; also all contractions, including contraction for the material used for the patterns, plus the contraction of the final casting material, since these obviously affect moulding taper; and as a final point, the patternmaker's drawing is a valuable check on the original drawing, for any dimensions inaccurately drawn are shown up immediately.

When the master pattern has been made and checked, whether by the foreman patternmaker or, in large establishments, by a pattern checker employed solely for that purpose, it is sent to the foundry. Here the requisite number of patterns are cast, and in the case of irregular joins, the cast plate is made for the casting of a number of patterns. On a cast plate the pre-master pattern for master patterns must have allowance for the two contractions involved, and for the convenience of the patternmoulder a plaster oddside should be made up in the pattern shop together with a wood or metal frame to act as a plate thickness piece. The making of the oddside in the pattern-shop will ensure that all patterns are located properly on the plate, and

Repetition Pattern Making

that they are so located from the point of view of mouldability that they will easily draw.

Double-sided Plates

The making of double sided cast plates is probably the most intricate in the whole of the craft, and credit must be paid here to the pattern moulder, without whose skill cast plates would not be possible. Their great disadvantage is high cost, involving as they do much patternmaking and moulding and a great deal of subsequent finishing; on the other hand, the ability to produce castings in quantity with irregular joints but without the necessity of expensive core making is of particular importance to-day, in view of the very high cost of core making, labour, and the exceptionally high cost of core-making material.

Mounting of multiple patterns may be simple or difficult according to the method of moulding employed. In the case of symmetrical half patterns mounted on a double-sided plate, no difficulty due to mismatching will be experienced if the following procedure be adopted. The half patterns are glued together and suitably sized holes are drilled right through both halves. The pattern is then taken apart, one half being mounted in position, and held while the holes are drilled through the plate, the other half then being located. There is then no possibility of cross jointing. The case of the matched plate is not quite so simple. A matched plate, as the name implies, means the mounting of half of an exactly symmetrical pattern, so that only half a pattern is required. The moulding procedure in this case is to make as many drag halves as are needed and then the same number of copes. The only alteration to the plate is the addition, for one half, of the necessary runner, and whether this is placed on the cope or drag will depend on the particular job itself.

With a matched plate the factor of real importance is to ensure that the half-pattern is so mounted on the plate as to coincide exactly with any other mould when this is reversed; that is, the locating of the cope on drag will produce a complete mould. The principle involved here is the same as that used for mounting patterns on twin plates, and by far the best way to obviate trouble is to work from centre lines on the plates. These lines should be scribed with absolute accuracy before any mounting is attempted, and preferably from box locating pins already in position in the plate. In the pattern shop concerned, the pattern pins are turned leaving a skirt or flange of 1-in. in diameter. The holes for these pins are jig drilled, ensuring absolute accuracy between centres on plates. Two lines are scribed along the plates from the top and bottom faces of the pin flanges and a centre line is obtained by means of dividers, a vertical line being obtained by means of again dividing from the inside edges of the pin flanges; and all marking out of centres or edges of patterns, whichever is the most convenient for the patternmaker, are taken from these lines.

Any errors resulting can only be due to carelessness, since the provision of the centres, as described, prevents the possibility of errors in mounting. After patterns have been mounted satisfactorily and sample castings have been approved and passed by the foundry inspector for symmetrical joint, essential dimensions and soundness, etc., the patterns should then be dowelled to the plates. This is essential in production work, since plain screwing rarely stands up to the incessant jolting and vibration of the power moulding machines, and for the same reason it is as well to centre pop round the edges of screws where possible, in order to prevent them from coming loose.

Core boxes should in all cases be dowelled, with the dowels offset so as to preclude the possibility of cross jointing of the two halves. Dowels are a far more positive location than tags or projecting ends. In this connection the same may be said of core carriers or driers. The function of the shell carrier is to support a core during the drying operation, when the core is of such shape that it cannot be dried on a flat plate and would otherwise sag and distort.

Shell Carriers

Core shell carriers may be made of a number of materials other than cast iron, although cast iron is by far the most popular. A simple method of core carrier manufacture for small quantities is as follows. The core box requiring carriers has a small shallow frame placed around it; plaster of Paris is poured into the frame and allowed to set. When thoroughly dry a small clearance is pared away from the edges, and the plaster block, together with wooden frames, is used as a core-box for the production of core driers in oil sand mixture. With reasonable care and handling these oil sand shells will last for a considerable time and have the advantage of low cost and also lower weight. Care must be taken when turning out a core into a shell that the green core is not crushed. This danger of crushing is a major drawback to the use of the oil sand drier, and location of drier to core-box is not easy. The usual method adopted is to mould holes in the carrier to locate over the pins on the half core-box.

Core Blowing

Core boxes made for use with the core blower should be studied from the point of view of venting, since few cores can be really successfully blown from a box which releases an air escape from joint faces only. The usual method adopted of scratching slight grooves from the faces of the core to the centre edges of the box with a file is definitely bad practice, and leads to rat-tail holes in the core. Core vents are expensive, but are the only satisfactory method of ensuring good cores from the blower. The vents are placed in the core-box in various positions from actual experience of cores blown on these types of machines.

Locating Pins

A most important aspect of production pattern equipment is the provision of suitable locating pins, particularly where boxes are closed by unskilled labour. The type of pattern plates most commonly used in the author's foundry is a cast iron plate for twin plate

production, to accommodate a box 20 inches by 14 inches, the plate being machined on both sides to ensure accuracy, and the pin holes jig drilled for the same reasons. In order to prevent copes being placed on drags in the reverse position, the pins are machined down to irregular sizes as follows: one side of both plates has a $\frac{1}{2}$-inch diameter pin, the other side the drag pin is $\frac{5}{8}$-inch diameter, and the cope pin $\frac{7}{8}$-inch diameter. The assembly pins required are thus one $\frac{1}{2}$-inch parallel pin and the other $\frac{5}{8}$-inch diameter at the bottom to locate on the $\frac{5}{8}$-inch hole in the drag, and the same pin at the top is $\frac{7}{8}$-inch to locate on the $\frac{7}{8}$-inch hole in the cope.

A further point with reference to pattern pins; the pins in all cases should be no longer than is necessary to ensure clearance of pattern taper in order to prevent moulding boxes sticking, as they are prone to do on long pins. A further point to be stressed is that constant checking of pins on plates, pin holes in moulding equipment and of closing pins is of vital importance in eliminating cross jointing of castings through wearing of these parts.

Patternmaking, in general, calls for the highest degree of skill and, for production work, the greatest accuracy and ingenuity. Loose pieces, for example, must be avoided wherever possible, especially on moulding tackle and core-boxes; except where cores are blown, in which case they are of less importance, although even here they are troublesome and are apt to be lost, especially if the core maker does not like the particular core he has to make!

In order to ascertain which particular pattern is giving trouble on a multiple plate, each pattern is numbered or marked in such a manner that examination of rejects will indicate whether any pattern gives consistently high scrap. Judicious application of crushing spaces and fillets, core-box clearance, etc., must be made, and each pattern must be virtually perfect before being passed for production.

In conclusion I would like to thank Mr. Bill, Mr. Ward, and Mr. Beal for their help, and African Malleable Foundries, Limited, for permission to publish this Paper.

To Present the French Exchange Paper

Mr. H. G. Hall, F.I.M., a director of Castings, Limited, of Walsall, has accepted an invitation to prepare a Paper on "Graphitisation in the Malleable Process," for presentation as the Exchange Paper on behalf of the Institute of British Foundrymen to the *Association Technique de Fonderie*, at their annual meeting to be held in Paris on October 8 and 9.

THE BRITISH EXHIBITION to be held in Copenhagen from September 18 to October 3 will be the largest and most comprehensive display of British goods ever held in Denmark, or in Scandinavia. At this exhibition, a wide range of goods of new design will be exhibited outside Britain for the first time. The exhibition is organised by the British Import Union of Copenhagen in co-operation with the Federation of British Industries and with the approval of H.M. and the Danish Governments.

Rehabilitation Expenses

By F. J. Tebbutt

A provision in the Finance Act, 1948, just passed, which should be noted, yet may have escaped notice, is really concessionary, being in connection with what is known officially as rehabilitation expenditure, and this applies to both Profits Tax and Income Tax. This expenditure is that incurred in the removal of A.R.P. installations; in the return of evacuated businesses to former (or other) location; or in the re-adaptation of buildings, machinery or plant to peace-time pursuits from war-time operations, and so forth. By previous Acts the work involving the expenditure was required ordinarily to be done before December 31, 1947, but if the Commissioners were informed (before March 31, 1948) that the work could not be done before December 31, 1947, further time could be allowed for the work to be done and still attract deductions for the cost from tax.

Now, by this 1948 Finance Act, if a preliminary statement of the work is given the Commissioners, with a full statement afterwards as to the exact position as regards the work and so forth, before March 31, 1949, the Commissioners are given discretionary powers to allow up to March 31, 1952, for the work to be done and the cost to still attract tax deductions. In short, the position now is that the Commissioners are allowed discretion concerning the allowing of the expenditure, even if the conditions of the original provision had not been observed, time limits and so forth, provided that the circumstances of the case warrant it.

Use of Wrong Sand Causes Wasters

By "Coroner"

The quality of the sand used in the non-ferrous foundry has to be such as to produce sound castings free from gas, and thus a special mixture, differing from that used in the ironfoundry, must be used. Invariably, the non-ferrous foundry is an entirely separate department from the iron section, but occasionally a centrally situated sand mill prepares sand for both departments. A certain casting was being made in a non-ferrous alloy with success, but suddenly scrap castings due to gas inclusions were encountered. Suspicion at first fell on the metal and the melting technique, and special precautions were taken thoroughly to degasify the metal before pouring, but the defect persisted. It was then suggested that the sand might be the cause of the trouble and an investigation proved this to be the right solution. While the sand used in this non-ferrous foundry was being mixed at the central milling station, a proportion of used ironfoundry sand had been inadvertently incorporated into the mixture. This sand, which contained coal dust and other gas-forming materials, was responsible for the waster castings, as the metal which had been completely de-gassed after melting had again picked up gas in its passage through the mould because of the presence of the coal dust and the other gas-forming materials.

Developing U.K. Tin Resources

Present Dependence on Overseas Sources

In contrast to the early years of the nineteenth century, Britain is now almost wholly dependent on overseas sources of supply for base metals. This point is made in a memorandum of the Cornish Mining Development Association, which it has submitted to the Minister of Fuel and Power. The memorandum outlines detailed proposals for the development of British non-ferrous metal resources.

After referring to our dependence on overseas sources of supply the memorandum says that this comparative cessation of operations could only be regarded with complacency if (*a*) it were definite that no mineral deposits worth raising remained; or (*b*) supplies from other sources were satisfying the market, and likely to continue to do so for a considerable time to come. "The reverse, however, is actually the case. Eminent mining engineers are confident that Britain still possesses considerable reserves of unmined non-ferrous minerals. At the same time, world supplies continue to fall short of the demand, and there is every prospect that a ready market will endure for all the metallic minerals that we can produce. The metalliferous mining industry in Cornwall has, therefore, a potential output which, if the country so decided, could contribute to the national income a quota much greater than that now yielded."

If private enterprise is to achieve larger non-ferrous metal production, the memorandum suggests that the following facilities and financial inducements would be necessary in this "high-risk field of investment":—(*a*) Undistributed mining profits to be free of taxation; (*b*) the first 20 per cent. of dividends paid by non-ferrous metal mining companies to be free of taxation; (*c*) higher priority for man-power and for the supply of machinery and equipment; (*d*) easier and more rapid acquisition of new and disused mining properties than is, in practice, obtained under the Mines (Working Facilities) Act, 1934; (*e*) a return to free market prices for tin and other non-ferrous metals; (*f*) the benefit of much extended Government research work.

Income-tax Relief

The document points out that the present income-tax revenue derived from the industry is but small and that the loss to the Exchequer by granting such reliefs would be infinitesimal, though the indirect benefit to the country would be considerable. Moreover, income-tax relief granted by certain countries with well-established mining industries, notably the U.S.A., Canada and Australia, is in marked contrast to that granted under the United Kingdom Finance Act of 1945.

The Association is of the opinion that, in view of the nature of the industry, nationalisation would not provide any solution to the problem. Nor is a direct subsidy on output with "the liberal measure of State control which would . . . inevitably accompany it." The memorandum therefore proposes that if the concessions to the industry given above are not acceptable, a Metalliferous Mining Development Corporation should be established for the whole of the United Kingdom "on the excellent model" of the North of Scotland Hydro-electric Board. The new authority should be essentially a business concern, and its suggested form is outlined in the statement.

Finally, the Association suggests that it should be possible to reach an output of 6,000-7,000 tons of tin metal per annum, or approximately one-third of average United Kingdom consumption.

Richardsons, Westgarth's Increased Orders

Predominance of Marine Work

An order-book in the region of £17,000,000, against around £12,000,000 a year ago, is recorded by Richardsons, Westgarth & Company, Limited, marine and general engineers, boilermakers, etc., of Hartlepool. Giving this information in his statement accompanying the company's annual accounts, Lt.-Col. Hugh M. Stobart, the chairman, says that 71 per cent. of the current order-book represents marine work and 29 per cent. land work.

After referring to difficulties in procuring materials in the year under review, the chairman says that, given stable conditions, the outlook for the company for the next few years is hopeful. "It should be borne in mind, however, that although there is evidence that the sellers' market of the last few years shows signs of coming to an end, there is little evidence so far of the steady increase in costs over the last few years being arrested. It is most essential that this country should compete in the world markets and, in order to do so, we must increase the efficiency of our production and decrease the cost of our products. Unless this can be achieved, it is inevitable that we shall experience a falling-off of orders with consequent unemployment and loss of prosperity."

The company's turnover during the year under review amounted to over £5,000,000, the net amount distributed by way of dividend being less than 1 per cent. of that total.

Shareholders of the company are to be asked to approve a resolution to provide that no director shall be liable to retire or be ineligible for reappointment under any age limit.

REFERENCE TO substantial progress having been made in the company's efforts to increase productive capacity is made by Mr. H. F. Smallwood, chairman of W. H. Dorman & Company, Limited, manufacturing engineers, etc., of Stafford, in a statement circulated with the annual report. He mentions that the new administrative block is nearing completion and that the new ironfoundry is now beginning to take shape.

World Production of Iron and Steel

Totals for 1947

Figures showing the production of iron and steel throughout the world during the first six months of 1947 were given in two tables published in our issue for December 12, 1947.

The accompanying tables give the corresponding figures, again extracted from the monthly bulletin of the Statistical Office of the United Nations, for the second half of 1947, together with the production totals for the year. Monthly averages in 1938 are stated for comparison. Footnotes contain those monthly figures which were not available when our earlier tables were published. All the figures are in thousands of metric tons, Table I referring to pig-iron and ferro-alloys, and Table II to steel ingots and castings.

Figures for Russia are again missing from the bulletin. Those given for Germany now include the French zone, and figures for the first half of last year, accordingly revised, appear in the footnotes. Production details of the Russian zone are also lacking.

THE U.S. DEPARTMENT OF COMMERCE has announced that, under a change in policy, limited quantities of tin-bearing alloys may be imported into the U.S. for the first time. Increased demand by industrial users of the material, mainly solder manufacturers, was the reason given by the Department for easing restrictions on these alloys.

THE CENTRAL PUBLIC WORKS DEPARTMENT of the Government of Pakistan, Chief Court Building, Karachi, would be interested in receiving catalogues and pamphlets on all building subjects and materials, including generating plant, air-conditioning plant, cranes, sanitary and electric fittings, lifts, etc. Communications should be sent to Mr. R. G. Wills, architect, at the above address.

TABLE I.—*World Production of Pig-iron and Ferro-alloys in the Second Half and Whole of* 1947 (*Thousands of Metric Tons*).

Countries.	Monthly average, 1938.	1947. July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year's total.
Australia ..	79	109	113	105	100	100	110	1,206
Austria	32.4*	33.6	35.5	39.3	40.1	36.5	33.1	278.4
Belgium	202	236	221	196	272	271	296	2,821
Brazil[1]	10.2	34.9	40.6	39.2	40.7	34.4	32.5	454.3
Canada	64	154	162	164	162	168	160	1,924
Czechoslovakia ..	110	120	120	119	125	117	121	1,423
France (*b*) ..	501	409	421	435	465	385	368	4,883
Germany†[2] ..	1,017‡	241	264	266	300	310	313	2,923
Hungary	27.9	26.6	28.4	29.2	27.6	25.5	24.3	299.4
India§[6]	131	122	124	122	136	142	128	1,564
Italy[3]	77.4	50.6	45.8	30.2	32.1	24.5	19.6	384.1
Japan (*a*) ..	214	34	34	32	32	38	37	355
Luxemburg ..	129	171	172	174	183	169	175	1,818
Netherlands[4] ..	22.2	27.6	10.6	25.8	27.1	25.7	29.3	288.1
Poland** ..	74	75	83	77	82	83	85	871
South Africa ..	24.5	54.7	56.3	51.9	57.2	50.1	49.3	635.9
Spain[5]	36.9	43.6	42.5	40.9	44.5	42.3	35.3	502.7
Sweden (*a*) ..	56.7	33.9	47.6	50.4	66.4	57	64.9	715.7
United Kingdom	572	726	597	610	818	675	838	7,906
U.S.A. (*b*) ..	1,589	4,159	4,460	4,355	4,743	4,550	4,697	53,707

* Relates to 1937. ** Pre-war territory. † Bizone and French zone only. ‡ Relates to 1936. § Excluding Pakistan as from September, 1947.

(*a*) Excluding ferro-alloys. (*b*) Excluding ferro-alloys made in electric furnaces.

1 Respective figures for January to June, 1947 (thousands of metric tons) :—42 ; 38 ; 39.3 ; 36.4 ; 38.9, and 37.4.

2 Revised figures for January to June, 1947 (thousands of metric tons) :—189 ; 168 ; 211 ; 226 ; 221, and 214.

3 Respective figures for January to June, 1947 (thousands of metric tons) :—13.8 ; 14 ; 18.3 ; 31.1 ; 52.1, and 52.

4 Respective figures for January to June, 1947 (thousands of metric tons) :—21.9 ; 19.1 ; 24.7 ; 27 ; 25.9, and 23.4.

5 Respective figures for January to June, 1947 (thousands of metric tons) :—41.4 ; 40.8 ; 42.3 ; 39.7 ; 46.2, and 43.2.

6 Respective figures for May and June, 1947 (thousands of metric tons) :—126 and again 126.

TABLE II.—*World Production of Steel Ingots and Castings in the Second Half and Whole of* 1947 (*Thousands of Metric Tons*).

Countries.	Monthly average, 1938.	1947. July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year's total.
Australia ..	98	106	119	117	109	108	112	1,250
Austria	54.2*	38.4	34.4	34.2	36.8	35.8	40.5	356.8
Belgium	190	241	227	209	293	268	296	2,894
Brazil[1]	7.7	29.6	31.6	28.9	28.5	24.9	34.1	381.6
Canada	98	211	212	212	233	232	227	2,673
Czechoslovakia ..	153	167	179	197	212	199	191	2,286
France	518	473	457	530	568	416	408	5,749
Germany†[2] ..	1,355**	383	406	396	448	416	415	4,305
Hungary	54	55.5	56.2	54.3	59.8	52.9	50.8	596.8
India‡[5]	82	101	92	88	103	109	113	1,224
Italy	194	170	154	147	163	156	143	1,701
Japan	539	91	90	88	96	92	87	943
Luxemburg ..	120	163	158	165	175	156	168	1,713
Mexico[4]	6.1	29.7	25.1	22.8	28.4	29.4	25.7	321.4
Poland§	120	141	144	143	145	148	140	1,579
South Africa[5] ..	25	44	56	50	53	45	56	605
Spain[6]	47.8	45.6	43.6	41.7	45.5	42.9	44.2	540.9
Sweden	83	65	92	94	105	100	117	1,191
United Kingdom	881	1,077	951	1,081	1,397	1,110	1,234	12,926
U.S.A.	2,400	5,960	6,334	6,159	6,859	6,562	6,682	76,915

* Relates to 1937. ** Relates to 1936. † Bizone (including iron castings) and French zone only. ‡ Excluding Pakistan as from September, 1947. § Pre-war territory.

1 Respective figures for January to June, 1947 (thousands of metric tons) :—34.3 ; 30.1; 33.7 ; 35 ; 37, and 33.3.

2 Revised figures for January to June, 1947 (thousands of metric tons) :—246 ; 254 ; 327; 333 ; 349, and 338.

3 Respective figures for April to June, 1947 (thousands of metric tons) :—105 ; 100 and 101.

4 Respective figures for May and June, 1947 (thousands of metric tons) :—26.4, and 25.9.

5 Respective figures for May and June, 1947 (thousands of metric tons) :—54 and 52.

6 Respective figures for January to June, 1947 (thousands of metric tons) :—44.4 ; 43.7 ; 49.7 ; 44.5 ; 47.3, and 47.8.

News in Brief

A STANDING JOINT COMMITTEE for developing recruitment and training in the foundry industry has been formed for the combined Smethwick, Halesowen and Oldbury Area.

MR. D. MORGAN, 11, Argyle Street, London, W.1, has been appointed liquidator (with a committee of inspection) for the voluntary winding-up of the Dolphin Engineering Company, Limited.

IRON ORE (95,431 tons) was the chief item of imports into the Wear during the first half of 1948, which totalled 193,875 tons, against 161,054 tons in the corresponding period of 1947 and a 1938 figure of 160,729 tons.

CHESTERFIELD CORPORATION has given approval in principle to an application for extensions to the works of the Sheepbridge Coal & Iron Company, Limited, subject to the submission of detailed plans at a later date.

A 56-TON BRIDGE was recently transported from the works of Palmers Hebburn Company, Limited, to Howdon (Northumberland) by a floating crane. The 105-ft. bridge will replace that damaged at the ferry landing.

WALES, LIMITED, manufacturers of bedsteads, of Birmingham, announces that a further delay has arisen in submitting the accounts by the requirements of the Companies Act, 1948, and the annual meeting will not be held before the end of September.

ALFRED HOLT & COMPANY, Liverpool, has placed orders with Harland & Wolff, Limited, for two further ships, each of which will be laid down at Belfast. One will be an 18-knot Diesel-driven cargo liner of 11,000 tons gross and the other a 15½-knot motorship of about 9,000 tons gross.

MR. J. ERIC STEEL, managing director of Steel & Company, Limited, Sunderland, has negotiated orders in America and Canada for mobile cranes worth £100,000. The cranes will be shipped to Canada. In America, says Mr. Steel, although there is considerable production of cranes, deliveries are slow.

MR. J. MALBORN, American representative for the Davy & United Engineering Company, Limited, who arrived in Sheffield recently, expressed the opinion that Sheffield's industries must re-equip to face ever-increasing competition from other European countries, and, if necessary, seek advice from America.

THE MAIN CONTRACTORS for the extensions to the works of the Skinningrove Iron Company, Limited, Loftus, Yorks, are George Wimpey & Company, Limited, Uxbridge, Middx, Cochranes (Middlesbro'), Foundry, Limited (for boilers), and Head, Wrightson & Company, Limited, Thornaby-on-Tees (for furnaces).

A WIDE RANGE OF Bendix radio equipment is to be produced under licence by the Plessey Company, Limited, Ilford, which has recently completed patent arrangements with the Bendix Corporation of America for the manufacture and sale of its equipment. The equipment includes mobile, ground and aircraft radio-communication systems and navigational aids.

Personal

DR. W. A. J. CHAPMAN, for nearly four years principal of the Stafford Technical College, has been appointed to a similar position at the new Hatfield Technical College. He has been chairman of the Wolverhampton section of the Institution of Production Engineers.

MR. F. WOODFIELD, a director and works manager of the Park Gate Iron & Steel Company, Limited, Rotherham, recently returned from America, where he has been attending the International Labour Conference in San Francisco. He is president of the Iron and Steel Trades Employers' Association.

MR. J. GORDON INNESS and MR. MALCOLM MCALLISTER have been elected directors of John G. Kincaid & Company, Limited, marine engineers and boilermakers, of Greenock. Mr. Inness has been with the company for the past 11 years, while Mr. McAllister, who has about 38 years' service to his credit, has been assistant secretary for the past two years.

MR. STANLEY BOOTH has retired after 49 years' service with the Workington Iron & Steel Company. To mark the occasion he was presented by his colleagues with a wallet containing Treasury notes. For a long period he was in charge of the pig-iron and ferro-alloys sales department of the company, now a subsidiary of the United Steel Companies, Limited.

MR. P. S. AVIS, whose retirement from his position as technical sales engineer, engineering department, of Edgar Allen & Company, Limited, Sheffield, took effect on July 31 last, joined the company in 1919 as assistant to the late Mr. W. J. Coles, then manager of the engineering department. Mr. Avis has for many years been responsible for the preparation of estimates and tenders for engineering work.

MR. AMBROSE SHARDLOW has been appointed joint managing director of Ambrose Shardlow & Company, Limited, manufacturers of drop forgings, crankshafts, etc., of Sheffield, with his father, Mr. Arthur T. Shardlow, chairman and managing director. Mr. Shardlow, sen., has been with the firm for 54 years. MR. R. H. UNWIN, who was made a works director last November, has joined the board. He started in the company's drawing office in 1923 and was in charge of that department for several years.

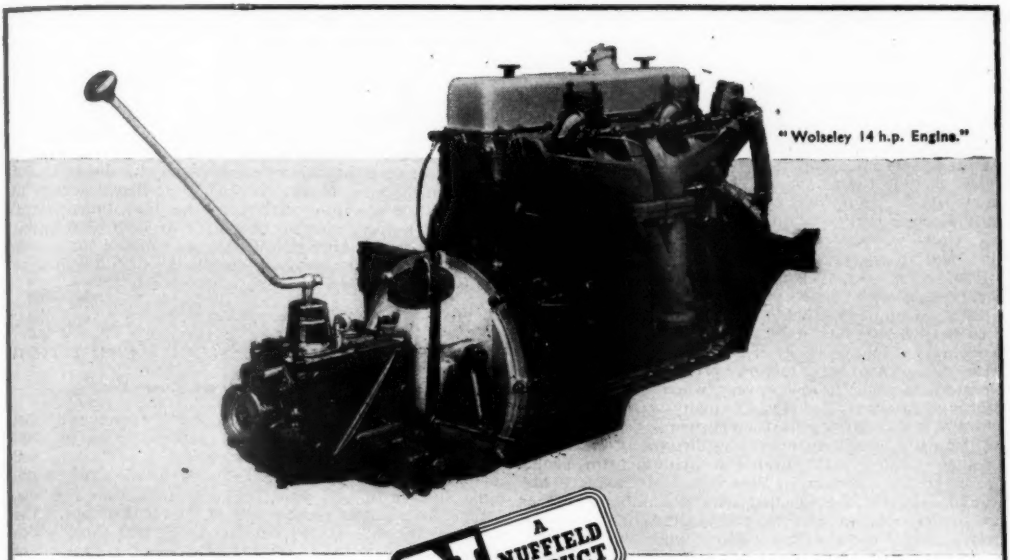
Wills

PALMOUR, SIR CHARLES JOHN GEOFFREY, chairman of Harland & Wolff, Limited, shipbuilders, of Belfast, from 1943-45 ... ... £36,091

GUDGEON, F. G., manager of International Combustion, Limited, Derby, formerly of Daniel Adamson, Limited, boilermakers, etc., of Dukinfield, Ches. £18,737

HEADLAND, T. P., managing director of Thomas P. Headland, Limited, engineers' merchants, steel stockholders, etc., of Westminster Bridge Road, London, S.E.1 ... ... £59,196

SPENCER & HALSTEAD, LIMITED, Ossett, Yorks, has received a £50,000 order for the erection of labour-saving plant at the Darlington works of Paton & Baldwins, Limited.



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REFINED PIG IRON

USED AND RECOMMENDED
FOR ALL HIGH-DUTY
ENGINEERING CASTINGS

THE STANTON IRONWORKS COMPANY LIMITED, Nr. NOTTINGHAM

Obituary

MR. JOHN KNIGHT, Scottish representative of the Wycliffe Foundry & Engineering Company, Limited, Follsain Metals, Limited, and Varatio-Strateline Gears, Limited, has died suddenly.

MR. JOHN COTTS, a partner in William Cotts & Sons, Limited, Queensberry Forge, Sanquhar, Dumfriesshire, died last week, aged 71. His family founded the works over a century ago and has specialised latterly in the forging of cast axles and other heavy castings. Mr. Cotts was the managing director until he became ill a few years ago.

MR. JAMES SHARPLES, chief A.I.D. inspector and metallurgist with the Sheepbridge Stokes Centrifugal Castings Company, Limited, died on August 4. Mr. Sharples, who was 65, joined Mr. F. W. Stokes at Mansfield in 1922 and worked on experiments in connection with the centrifugal casting process. He went to Chesterfield in the following year, when the Sheepbridge Stokes Centrifugal Castings Company was formed.

MR. WILFRED MORLEY RATCLIFFE, whose death occurred on August 6, was joint managing director of Heenan & Froude, Limited, structural and manufacturing engineers and ironfounders, of Worcester. He was 62. Mr. Ratcliffe was also associated with a number of other companies. He was chairman of Court Works, Limited, ironfounders, of Madeley, Salop, while his directorships included Associated Locomotive Equipment, Limited; Caprotti Valve Gears, Limited; Fielding & Platt, Limited; Jones Gas Process Company, Limited. and Toledo Woodhead Springs, Limited.

MR. HORACE HAMPTON, chairman and joint managing director of C. & J. Hampton, Limited, toolmakers and ironfounders, of Sheffield, has died in London. He had been associated with the hand-tool industry for over 40 years. Mr. Hampton was a Freeman of the Cutlers' Company and a member of the Council of the Sheffield Chamber of Commerce. He was an honorary adviser to the Director of Hand Tools in the Ministry of Supply, president of the Engineers' and Allied Hand Toolmakers' Association and vice-chairman of the British Council in London of the Australian Association of British Manufacturers.

MR. JOHN R. COWIE, who died on August 5, had been in the service of A. Reyrolle & Company, Limited, manufacturing electrical engineers, of Hebburn, Co. Durham, since about 1920, when he went to London as personal assistant to the late Mr. H. W. Clothier to establish an office there for the company. He later became manager of the company's Southern area. Mr. Cowie served a term on the Council of the Institution of Electrical Engineers; he was also for one year president of the Association of Mining and Mechanical Engineers, and in February of this year he was installed as chairman of the Council of the British Electrical and Allied Industries Research Association.

MR. SIDNEY GEORGE BROWN, F.R.S., died at Sidmouth, Devon, on August 7, after a long illness. He was formerly a director of S. G. Brown, Limited, manufacturers of gyroscopic compasses and electrical instruments, of Acton, London, W.3, and also of the Telegraph Condenser Company, Limited, Acton. His wife, Mrs. Alice S. G. Brown, who survives him, was also on the board of these companies. Mr. Brown, who was 75, was a successful inventor, having some 1,000 patents to his credit. His chief work was in the fields of submarine telegraphy and long-distance telephony. In 1915 he was made a member of the research committee which was charged with the task of discovering a satisfactory means of detecting enemy submarines at a distance, and later in the year he was invited by the Royal Society to serve as a scientific adviser to the Inventions Board. In 1917 he was chosen one of two civilian scientific advisers on the Admiralty Ordnance Council for awards to inventors. It was during the first world war that he constructed his gyro compass.

Holidays Affected Steel Production

But Output was Up on Last Year

Holidays interfered with steel production last month, with the result that output was at the reduced annual rate of 12,084,000, which was, nevertheless, well above the rate of 11,008,000 tons in the corresponding month of last year. Steel production in June, 1948, was at the record rate of 15,444,000 tons. The annual output rate to date is 14,723,000 tons, which compares with the revised Government target of 14,500,000 tons for 1948.

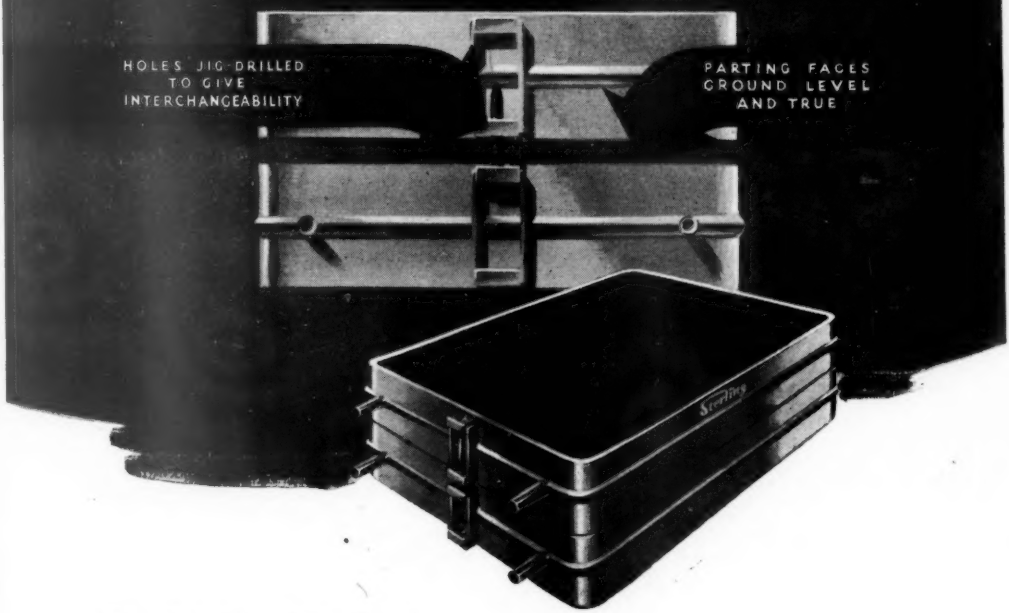
Pig-iron production last month was at an annual rate of 8,908,000, compared with 7,460,000 tons a year ago.

	Pig-iron.		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
	Tons.	Tons.	Tons.	Tons.
1948—1st quarter ..	175,000	9,084,000	287,000	14,933,000
2nd quarter ..	182,000	9,464,000	295,000	15,323,000
July	171,000	8,908,000	232,000	12,084,000
1947—1st quarter ..	134,000	6,990,000	216,000	11,232,000
2nd quarter ..	142,000	7,362,000	244,000	12,694,000
July	144,000	7,460,000	212,000	11,008,000

Orders for Tankers on N.-E. Coast

Orders for seven tankers have been received by shipyards on the Tyne, Wear and Tees for the Overseas Tankship Corporation of New York. Three tankers will be of 16,500 tons dw. each and four of 12,000 tons—a total of nearly 100,000 tons of oil tank shipping. Two of the ships will be built by R. & W. Hawthorn, Leslie & Company, Limited, on the Tyne and the third by the Furness Shipbuilding Company, Limited, at Haverton Hill-on-Tees. The four 12,000-tonners will be built and engined by William Doxford & Sons, Limited, Sunderland. The three larger ships will have steam turbines and the four smaller ones Doxford Diesel engines. It is understood that ships of the corporation's fleet will be dry-docked, surveyed and repaired in Britain.

DESIGN FOR ACCURACY



The Sterling Standard—2

STERLING Moulding Boxes are standard equipment in modern factories everywhere. Such universal acceptance is, naturally, based on all-round efficiency; Sterling limits are the closest in the trade and consistent accuracy, which is maintained in service, influences many foundrymen in deciding that . . . in foundry equipment the standard is STERLING.

ROLLED STEEL **Sterling** MOULDING BOXES

STERLING FOUNDRY SPECIALTIES LTD., BEDFORD, ENGLAND.

Company News

(Figures for previous year in brackets.)

Charles Neil & Company—Interim dividend of 25%, tax free (same).

Guest, Keen & Nettlefolds—Final dividend of 7%, making 11% (same).

Newton Bros. (Derby)—Dividend of 17½% (same) and special bonus of 7½% (same).

George Cohen, Sons & Company—Final dividend of 12%, making 20%. The company was made public in March, 1947.

Steel & Company—Net profit, after taxation, for the year ended March 31, £60,201 (£47,490); to preference dividends, £9,488 (£7,582); ordinary dividend of 17½% (same); forward, £54,869 (£28,218).

Bradley & Company—Combined statement shows total trading profit for 1947, £124,859; other income, £1,418; to directors' remuneration, £13,828; depreciation, £9,172; debenture interest, £1,345; non-recurring expenditure, £10,043; leaving £91,889, of which £42,514 attributable to the parent company; to tax, £26,042; preference dividend, £1,320; dividend of 70 per cent. on the ordinary shares, £19,250; forward, £44,707 (£48,805). The company was made public last March.

W. H. Dorman & Company—Trading profit to March 31, £157,460 (£181,957); interest, £1,010 (£1,066); to depreciation, £20,369 (£18,557); directors' fees, £300 (same); auditors' fee and expenses, £630 (£483); interest on 5% notes, £3,734 (£3,751); pensions, £4,064 (£3,909); loss on sale of Government securities, £2,098 (nil); net profit, £127,275 (£156,023); dividend of 37½% (same); taxation, £67,500 (£110,000); deferred repairs, £26,500 (£10,300); general reserve, £20,000 (same); capital reserve, nil (£398); forward, £8,320 (£8,692).

Richardsons, Westgarth & Company—Trading profit for the year ended March 31, £482,854 (£472,241); other income, £5,549 (£6,473); to directors' fees, £2,400 (same); auditors' remuneration, £1,055 (£1,053); depreciation, £72,967 (£55,485); bank interest, nil (£2,357); taxation, £250,000 (£290,000); net profit, £161,981 (£127,419); dividend of 8% (10%); to general reserves, £110,000 (£60,000); forward, £60,913 (£55,644). The directors also propose this year a distribution of 2%, not subject to tax, from capital reserve account.

Murex—Consolidated profit and loss account for the period from July 1, 1947, to April 30, 1948, shows trading profits, etc., of £696,713 (£432,346 for the year); to depreciation, £108,088 (£120,843); directors' fees, £4,467 (£5,150); other emoluments, £16,370 (£12,197); auditors, £897 (£829); preference issue expenses, £16,634 (nil); repairs, nil (£30,000); income tax, £212,148 (£92,380); profits tax, £87,600 (nil); balance, including £16,198 in respect of one subsidiary for 16 months. £250,509 (£170,947); surplus on sale of shares in an associated company, £32,499 (nil); to general reserve, £183,000 (£62,500); Murex preference 7% dividend, £1,925 (same); preference 4%, £4,810 (nil); ordinary dividend, £91,667 (£110,000); subsidiary minority, £678 (£478); balances forward:—Murex, £126,428 (£125,600); subsidiary minority, £331 (£231); final dividend on ordinary shares of 12½% per annum, making 20% per annum (same rate).

New Companies

("Limited" is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

Ringwood Engineering, Regent House, 89, Kingsway, London, W.C.2—£10,000. E. E. Alflatt, A. H. D. Fairbarns, F. Pascall, and J. M. Bates.

Gush & Dent, 2, Old George Flats, Alresford, Hants—Agricultural and general engineers, etc. £6,000. G. B. Gush, R. F. Dent, and S. C. R. Huggett.

Francis & John S. Lane, Lanwill Works, Silver End, near Brierley Hill—Manufacturers of colliery plant, general engineers, etc. £60,000. J. S. Lane and S. C. Elcock.

Berry Hill (Engineers)—To take over the business carried on at Cheadle by F. W. Lobenhoffer and his predecessors. £25,000. F. W. Lobenhoffer, The Cottage, Cheadle.

Bestwood Development Company, Equitable House, South Parade, Nottingham—To take over the whole or any part of the assets, liabilities and undertaking of the Bestwood Coal & Iron Company, and to carry on business of constructors of engines, machinery, etc. £500.

Deritend Precision Castings, Liverpool Street, Birmingham—To enter into an agreement with Deritend Stamping Company, and Trucast, and to carry on business of iron and brass founders, etc. £30,000. J. W. and R. W. N. Danielsen, G. B. Jenks, and G. E. Robinson.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained.

Biddulph, September 7—Contract No. 2:—Construction of approx. 6¼ miles of sewers, 18-in. to 6-in. dia., in cast-iron and stoneware pipes, etc., for the Urban District Council. Mr. J. H. Walters, engineer, 19, Moody Street, Congleton. (Fee £5 5s., returnable.)

Wantage, August 28—(1) Provision and laying of about 860 yds. of 8-in. cast-iron main. (2) Provision and installation of a 15,000-g.p.h. booster pump, for the Urban District Council. Mr. G. Allsebrook, 29, Crown Street, Reading. (Fee £2 2s., returnable.)

Gazette

MR. C. M. CALVERLEY, 115, Chancery Lane, Strand, London, W.C.2, has been appointed liquidator (with a committee of inspection) for the voluntary winding-up of the Mallord Engineering Company, Limited.

THE PARTNERSHIP BETWEEN Frank McAvady, Fred Woollacott and Clifford Wood, carrying on business as gas-meter engineers, at Greenbridge Lane, Greenfield, Yorks, and at Daniel Street, Oldham, Lancs, under the style of the Viaduct Meter Company, has been dissolved. Debts will be received and paid by F. McAvady and F. Woollacott, who continue.

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STRAIGHT THROUGH AND "U" TYPES
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"TICYL"

THE IRON YOU CAN ALWAYS RELY ON

FOR CYLINDER & HIGH DUTY CASTINGS

"TICYL" is the perfect pig-iron for cylinder and high duty castings . . free from porosity and of high tensile strength. Our Technical Staff is always ready to assist users and to advise with regard to mixtures. We cordially welcome your inquiries.

'Phone: 66248/9 Bloxwich. 'Grams: Thomas, Bloxwich.

G. & R. THOMAS LTD., HATHERTON BLAST FURNACES, BLOXWICH, STAFFORDSHIRE.

FAMOUS SINCE 1844

Raw Material Markets

Iron and Steel

Foundries are receiving reasonably good supplies of coke and some users are building up small stocks. The recent price increase has not so far affected demand. Pig-iron, however, particularly high-phosphorus iron, is still in short supply and many foundries are having difficulty in getting even licensed tonnages. Stocks generally are low and the stringency is aggravated by the continued scarcity of scrap. General engineering and jobbing foundries do not find the pig-iron position too secure and would welcome more low- and medium-phosphorus iron; in addition, there is not enough hematite to keep all supplied. Fortunately, refined iron is in reasonably good supply. Requirements in ferro-alloys are well satisfied and regular deliveries of limestone and ganister are being made. There is, however, some delay in the execution of cupola-brick orders.

Supplies of semis to the re-rollers fall far short of requirements. Some of the larger mills are not so badly placed as the smaller units, but there remains a dearth of small billets, square and flat, which makes it extremely difficult for users to obtain small-size rounds and squares, and narrow and thin strip. All strip mills are working to capacity in an effort to meet the huge demand for their products. Rollers are glad to accept from the steelworks any type of defective billet, sheet bar, crops, etc.

It has become difficult, if not impossible, to place orders for any class of finished steel products for delivery before the end of Period III. Sheets and plates of all thicknesses are in the heaviest demand, but rail, section and wire mills are also engaged to the limit of their capacity; home requirements are so substantial that, urgent as is the need for the expansion of the export trade, the export quotas cannot be increased. Complaints are being made that the requisitions from the National Coal Board are excessive, and it is suggested that in the present state of supply and demand, steel for the pits should not be requisitioned until it is required for immediate use.

Non-ferrous Metals

A very firm tone is still in evidence in the United States and a number of factors are contributing to make the possibility of any setback unlikely. In the van of this upward movement is lead, the U.S. domestic production of which is limited by labour trouble at one of the mines. Consumers are reported to be looking to Europe to help in this time of scarcity and, in consequence, the domestic price of 19½ cents per lb. is being exceeded in a number of directions through the incidence of ocean freight, import duty, etc. In copper, sales keep up well and there are no signs of any falling away at the moment. It is now reported that the threatened strike at the Utah mine has been postponed more or less indefinitely, even though a settlement of the dispute is not believed to have been reached. The export price of the metal is 23½ cents per lb., f.a.s., but the volume of business done so far in August has not been very large. Nor for that matter has there been much movement in the United Kingdom, for scrap merchants report an intermittent and somewhat feeble demand for secondary metals. This month is likely to be quiet, due to holidays. It seems as if efforts are being made to have the suspension of the import duty on copper in America, at present on a temporary basis until July next year, extended until the early months of 1952.

Last week it became known that the Ministry of Supply had issued edicts relating to the buying of both copper and zinc to take effect as from August 1. The restriction for copper limits the power of consumers to acquire licences in any one month to a tonnage not greater than their average monthly consumption during the final quarter of 1947. This basis, it will be remembered, was employed when a decision was reached last March to restrict consumption by 7 per cent., but at that time nothing was done about zinc. This new plan to put a check on the buying of zinc is similar to that for copper, except that the scheme rests on the average monthly consumption of zinc during the first half of this year. It would seem that the Ministry of Supply, not having advanced its selling prices, is seeking protection against the possibility of being overwhelmed by a semi-speculative demand from the users of these metals.

U.S. Steel Corporation

Earnings of the United States Steel Corporation in the second quarter of 1948 were equivalent to $3.02 per share of common stock, against $3.18 in the first quarter and $2.65 in the second quarter of 1947. Thus for the six months ended June 30 the Corporation earned $6.20 per share ($6.43 in the same period of last year). The net profit in the quarter ended June 30 was $32,586,000 ($29,337,000 in the same period of last year and $33,957,000 in the first quarter of 1948). In the first six months of this year the net profit was $66,543,000 ($68,571,000).

Industrial Activity in May

A provisional calculation of the interim index of industrial production, based on a limited amount of data, shows the volume of production in May at 118 per cent. of the average in 1946, compared with the April figure of 124 per cent. The volume of production in May, 1947, was 110 per cent. These figures are adjusted for the number of days (excluding Sundays) in each month. The preliminary calculation shows a falling off in the level of activity in May, reflecting largely the loss of production at Whitsuntide.

THE MINISTRY OF SUPPLY has announced that interim allocations of tin metal for the second half of 1948, totalling 1,450 tons, have been made. They are additional to those announced on July 16.